

MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY,

CONTAINING

PAPERS, ABSTRACTS OF PAPERS, AND

REPORTS OF THE PROCEEDINGS

OF THE SOCIETY

FROM NOVEMBER 1900 TO NOVEMBER 1901.

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MONTHLY NOTICES

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ROYAL ASTRONOMICAL SOCIETY.

VOL. LXI.

NOVEMBER 9, 1900.

No. 1

E. B. KNOBEL, Esq., President, in the Chair.

A. H. Baker, B.A., Head Master, Basnett Road Board School,
Lavender Hill, S.W. ;

William Henry Colegrave, Master Mariner, Little Tew,
Enstone, Oxford ; and

Guy François Comte Meredyth de Miremont, Orleans Club,
St. James's, S.W., and Littlecot, Worthing, Sussex.

were balloted for and duly elected Fellows of the Society.

The following candidates were proposed for election as
Fellows of the Society, the names of the proposers from personal
knowledge being appended :—

Charles Anthony, jun., M.I.C.E., Casilla 1045, Buenos
Aires, Argentine Republic (proposed by Sir R. S. Ball) ;

Henry Osmund Barnard, Superintendent, Trigonometrical
Survey, Survey Department, Ceylon (proposed by Capt.
P. B. Molesworth) ;

Archibald Young Gipps Campbell, Civil Service of India
(proposed by Sir R. S. Ball) ;

Charles Davidson, Established Computer, Royal Observatory,
Greenwich, 41 Park Street, Greenwich, S.E. (proposed
by W. H. M. Christie) ;

Frank C. Dumat, Advocate, Johannesburg, South Africa
(proposed by E. Nevill) ;

Ambrose T. Flagg, M.A., Head Master, Navigation School,
Chapel House, Westoe, South Shields (proposed by
Thomas Lewis) ;

- Walter Heath, M.A., Redcott, Cobham, Surrey (proposed by J. W. L. Glaisher);
- John Charles William Herschel, B.A. Oxon, St. John's College, Cambridge, and Lawn Upton, Littlemore, near Oxford (proposed by Sir R. S. Ball);
- Capt. Joseph W. Martyr, s.s. "Montrose," 1 The Glen, South Road, Forest Hill, S.E. (proposed by Campbell Hepworth);
- Alfred Ernest Moore, B.A., B.Sc. Lond., Lecturer in Mathematics and Physical Science, St. John's College, Battersea, S.W. (proposed by A. Fowler);
- John Netherclift Jutsum, Teacher of Navigation and Nautical Astronomy, Cardiff Nautical Academy, 47 St. Mary Street, Cardiff, S. Wales (proposed by Arthur Mee);
- Thomas Marginson Nightingale, B.Sc., 375 Bridgeman Street, Bolton, Lancashire (proposed by A. Fowler); and
- Richard Welford, Thornfield Villa, Gosforth, near Newcastle-on-Tyne (proposed by Cuthbert Hutchinson).

One hundred and eighty-eight presents were announced as having been received since the last meeting, including, amongst others :—

J. C. Adams, *Scientific Papers*, vol. ii., presented by the Adams Memorial Committee; Ch. André, *Traité d'astronomie stellaire*, 2me partie, presented by the author; Batavia, Natural History Society, Solar eclipse of 1901; information for observing parties, &c., presented by A. M. W. Downing; Groningen Astronomical Laboratory, publications Nos. 1-3, presented by the Laboratory; Leipzig, *Astronomische Gesellschaft*, *Catalog der Sterne*, Zone +10° bis +15° (Leipzig), presented by the Society; Lowell Observatory *Annals*, vol. ii., presented by Percival Lowell; Madrid Observatory, *Observaciones del eclipse total 1900 in Plasencia*, presented by the Observatory; E. W. Maunder, The Royal Observatory, Greenwich, presented by the publishers; Princeton University, Report of the eclipse expedition, 1900, presented by C. A. Young; Washington, *American Ephemeris Papers*, vol. v., pts. 1, 2; vol. viii., pt. 1 (Newcomb, *Perturbative Function*, *Inequalities of long period*, *Precessional Constant*), presented by the Ephemeris Office. *Carte photographique du ciel*, 70 charts, from photographs taken at the Observatories of Algiers, Paris, Toulouse, and San Fernando, presented by the Paris and San Fernando Observatories; Collection of astronomical drawings (Moon and planets) by the late N. E. Green, presented by Miss Green; Photographs of the total solar eclipse, 1900 May 28, presented by C. Burckhalter; Photographs of the Sun and of the solar eclipse, 1900 May 28 (partial

phase), presented by G. J. Newbegin ; Photographs of instruments for eclipse observations and enlarged photograph of the transit of *Venus*, 1882, presented by D. P. Todd ; Portrait of the late Professor J. E. Keeler, presented by the Lick Observatory ; Small equatorially mounted telescope, formerly belonging to the late Mr. B. T. Moore, presented by Miss Moore.

Mean Areas and Heliographic Latitudes of Sun-spots in the year 1899, deduced from Photographs taken at the Royal Observatory, Greenwich, at Dehra Dûn (India), and in Mauritius.

(Communicated by the Astronomer Royal.)

The results here given are in continuation of those printed in the *Monthly Notices*, vol. lx. p. 157, and are deduced from the measurements of solar photographs taken at the Royal Observatory, Greenwich ; at Dehra Dûn, India ; and at the Royal Alfred Observatory, Mauritius.

Table I. gives the mean daily areas of umbræ, whole spots, and faculæ for each synodic rotation of the Sun in 1899 ; and Table II. gives the same particulars for the entire year 1899 and the ten preceding years, for the sake of comparison. The areas are given in two forms : first, projected areas—that is to say, as seen and measured on the photographs, these being expressed in millionths of the Sun's apparent disc ; and next, areas as corrected for foreshortening, the areas in this case being expressed in millionths of the Sun's visible hemisphere.

Table III. exhibits for each rotation in 1899 the mean daily area of whole spots, the mean heliographic latitude of the spotted area, and the mean distance from the equator of all spots ; and Table IV. gives the same information for the year as a whole similar results from 1889 to 1898 being added, as in the case of Table II. Tables II. and IV. are thus in continuation of the similar tables for the years 1874 to 1888, on pp. 381 and 382 of vol. xlix. of the *Monthly Notices*.

The rotations in Table I. and Table III. are numbered in continuation of Carrington's series (*Observations of Solar Spots made at Redhill*, by R. C. Carrington, F.R.S.), No. 1 being the rotation commencing 1853 November 9. The assumed prime meridian is that which passed through the ascending node at mean noon on 1854 January 1, and the assumed period of the Sun's sidereal rotation is 25·38 days. The dates of the commencement of the rotations are given in Greenwich civil time, reckoning from mean midnight.

TABLE I.

No. of Rotation.	Date of Commencement of each Rotation.	No. of Days on which Photographs were taken.	Mean of Daily Areas.					
			Projected		Corrected for Foreshortening.			
			Umbra.	Whole Spots.	Faculae.	Umbra.	Whole Spots.	Faculae.
605	1898 Dec. 18 ²⁰	27	44	271	399	28	182	436
606	1899 Jan. 14 ⁵³	27	28	154	402	19	108	424
607	Feb. 10 ⁸⁷	27	70	38	218	70	36	248
608	Mar. 10 ²⁰	28	82	485	441	55	336	474
609	Apr. 6 ⁵⁰	27	30	159	344	22	116	411
610	May 3 ⁷⁶	27	96	61	211	71	44	259
611	May 30 ⁹⁷	27	29	173	410	22	137	487
612	June 27 ¹⁷	27	73	448	439	49	301	483
613	July 24 ³⁷	27	50	21	345	27	15	365
614	Aug. 20 ⁶⁰	27	0	30	161	0	21	177
615	Sept. 16 ⁸⁶	28	97	54	160	56	30	185
616	Oct. 14 ¹⁴	27	20	129	152	13	81	198
617	Nov. 10 ⁴⁴	28	13	67	233	85	48	279
618	Dec. 7 ⁷⁶	27	99	72	263	69	51	277

TABLE II.

Year.	No. of Days on which Photographs were taken.	Mean of Daily Areas.					
		Projected.		Corrected for Foreshortening.			
		Umbræ.	Whole Spots.	Faculæ.	Umbræ.	Whole Spots.	Faculæ.
1889	360	17.9	103	107	13.1	78.0	131
1890	361	21.3	133	273	15.5	99.4	304
1891	363	120	745	1322	86.2	569	1412
1892	362	255	1596	3230	186	1214	3270
1893	362	327	1983	2287	234	1464	2404
1894	364	317	1728	1666	231	1282	1877
1895	364	237	1330	2059	169	974	2278
1896	364	127	745	1243	90	543	1410
1897	364	122	695	977	88	514	1149
1898	363	93	532	767	64	375	891
1899	364	27	159	297	18	111	337

TABLE III.

No. of Rotation.	Date of Commencement of each Rotation.	No. of Days on which Photographs were taken.	Spots North of the Equator. Mean of Daily Areas.	Mean Heliographic Latitude.	Spots South of the Equator. Mean of Daily Areas.	Mean Heliographic Latitude of Entire Spotted Area.	Mean Distance from Equator of all Spots.
605	1898 Dec. 18.20	27	45	8.45	178	-11.17	11.60
606	1899 Jan. 14.53	27	0.1	7.95	108	-11.04	11.05
607	Feb. 10.87	27	0.0	...	36	-5.39	5.39
608	Mar. 10.20	28	55	10.75	331	-9.67	10.03
609	Apr. 6.50	27	11	9.52	105	-8.85	10.70
610	May 3.76	27	0.0	...	44	-11.84	11.84
611	May 30.97	27	97	5.95	41	+0.39	8.00
612	June 27.17	27	150	5.93	152	-2.09	7.98
613	July 24.37	27	0.0	...	15	-11.58	11.58
614	Aug. 20.60	27	0.4	2.95	17	-7.94	9.03
615	Sept. 16.36	28	15	4.18	15	-4.14	8.25
616	Oct. 14.14	27	0.1	6.95	81	-9.94	9.96
617	Nov. 10.44	28	4.1	3.96	44	-6.55	7.23
618	Dec. 7.76	27	29	7.16	22	-0.97	9.09

TABLE IV.

Year.	No. of Days on which Photographs were taken.	Spots North of the Equator. Mean of Daily Areas.	Mean Heli- graphic Latitude.	Spots South of the Equator. Mean of Daily Areas.	Mean Heli- graphic Latitude.	Mean Heliographic Latitude of Entire Spotted Area.	Mean Distance from Equator of all Spots.
1889	360	50	7°26'	730	11°90'	- 10°68'	11°61'
1890	361	531	22°20'	463	21°75'	+ 1°73'	21°99'
1891	363	401	20°49'	169	19°91'	+ 8°52'	20°31'
1892	362	607	15°09'	607	21°69'	- 3°29'	18°39'
1893	360	517	14°91'	941	14°26'	- 3°93'	14°49'
1894	364	543	12°31'	739	15°56'	- 3°75'	14°18'
1895	364	565	14°26'	409	12°54'	+ 3°01'	13°54'
1896	364	203	13°60'	340	14°77'	- 4°15'	14°33'
1897	364	196	8°32'	318	7°73'	- 1°62'	7°96'
1898	363	110	9°82'	266	10°77'	- 4°75'	10°49'
1899	364	23	6°18'	88	10°43'	- 6°95'	9°54'

The principal features of the record for 1899 are :—

(1) The decline in area of umbræ, whole spots, and faculæ has gone on with great rapidity ; the decrease in mean daily spotted area amounting to 70 per cent. for 1899, as compared with 1898, and to 78 per cent. as compared with 1897.

(2) The decrease in the area of the umbræ has been in almost exactly the same proportion as for the whole spots—72 per cent. as compared with 1898, 80 per cent. as compared with 1897.

(3) The decrease in the area of the faculæ has been almost as great—62 per cent. as compared with 1898, 71 per cent. as compared with 1897.

(4) The northern hemisphere has been much the least active, giving only one-fifth of the total mean daily spotted area.

(5) The rate of decline in the two hemispheres has not been very different, but has been greatest in the northern ; the decrease, as compared with 1898, is 79 per cent. for the northern hemisphere, and 67 for the southern.

(6) The two chief outbreaks of the year occurred in March and June respectively, but were both very far inferior to the great group of September 1898 ; indeed, neither of them would have been at all noticeable at the period of maximum. The first of these groups was first seen near the east limb on March 15, and disappeared at the west limb on March 27. It was seen only during the one rotation. The other group was first seen on the east limb on June 23, having formed on the further hemisphere. It consisted at first chiefly of one very large regular spot, and like the March group was seen only during one passage.

(7) The distribution of the spots in latitude in 1899 has been marked by a slight approach towards the equator, the mean distance being $9^{\circ}54'$ as compared with $10^{\circ}49'$ in 1898. This latitude is distinctly higher than that for the year 1887 in the last cycle, but is almost exactly the same as for 1877 in the preceding cycle.

(8) The number of days without spots has very greatly increased, having risen to 123, as against 48 for 1898. The number of days without faculæ has increased even in a larger ratio, being 105, as against 11 in 1898.

(9) As compared with 1887, the mean daily spotted area is much smaller, being 111 as against 179 ; so that the decline towards the minimum would, so far as this element is concerned, seem to be further advanced in 1899 than in 1887. The number of days without spots also supports the same conclusion. The mean distance of the spots from the equator rather points to 1899 being further from the minimum than was 1887. On the whole, if the general progress of the present cycle follows the course of the last, the next minimum should fall sometime in the latter half of 1901.

*Micrometric Measures of the Diameter of Neptune and distance and position-angle of the Satellite made with the 28-inch refractor at the Royal Observatory, Greenwich.**(Communicated by the Astronomer Royal.)*

The following measures were made with the full aperture of the 28-inch refractor and a power of 670. No correction for irradiation has been applied to the measures of diameters.

The initials L., B., W. B. are those of Mr. Lewis, Mr. Bryant, and Mr. Bowyer respectively.

Micrometric Measures of the Diameter of Neptune.

Date.	Apparent Diameter.		No. of Measures.	Diameter reduced to mean distance, 30'05508.		Observer.
	Equatorial.	Polar.		Equatorial.	Polar.	
1896.						
Nov. 18	2'10	2'03	10, 10	2'02	1'96	L.
20	2'05	1'91	10, 10	1'98	1'83	"
1897.						
Dec. 17	2'03	2'10	10, 10	1'95	2'02	"
20	...	2'14	6	...	2'07	W.B.
22	2'34	...	10	2'25	...	B.
	2'38	2'27	10, 10	2'27	2'18	L.
24	2'20	2'64	8, 8	2'11	2'54	W.B.

Micrometric Measures of the Satellite of Neptune.

Date and Mean Time.				Sidereal Time.	No. of Measures.	Apparent Distance.	Distance reduced to mean distance of Neptune (30'05508).	Position-Angle.	Observer.
1896. d	h	m	s	h m s		"	"	° ' "	L.
Nov. 18	12	38	9	4 32 20	8	15'94	15'35	... 1	L.
	12	33	12	4 27 22	4	...	...	264 9	"
30	11	38	32	4 19 52	10	17'35	16'68	...	"
	11	38	8	4 19 28	4	...	...	251 53	"
Dec. 7	11	7	56	4 16 47	6	13'17	12'95	...	"
	11	9	17	4 18 8	4	...	...	204 2	"
31	9	29	42	4 12 54	10	11'06	10'65	...	"
	9	18	56	4 2 6	4	...	...	167 30	"
1897									
Nov. 29	9	42	52	2 19 0	13	14'94	14'37	...	"
	9	38	48	2 14 55	4	...	...	275 8	"
Dec. 3	10	57	1	3 49 7	5	16'09	15'46	...	"
	10	50	49	3 42 53	4	...	...	58 55	"
17	10	5	20	3 53 29	10	16'74	16'09	...	"
	9	56	27	3 44 34	4	...	...	258 18	"

Date and Mean Time.				Sidereal Time.	No. of Measures.	Apparent Distance.	Distance reduced to mean distance of Neptune (30°05508').	Position-Angle.	Observer.	
1897. d	h	m	s	h	m	s		°	'	
Dec. 20	10	53	36	4	52	42	16	17°92	17°23	° ... ' W. B.
	10	50	57	4	50	3	4	...	...	77 26 „
22	9	24	30	3	31	16	10	11°82	11°36	... B.
	9	24	15	3	31	0	8	...	...	309 10 „
	10	21	20	4	28	14	10	11°55	11°11	... L.
	10	21	22	4	28	17	5	...	...	303 4 „
23	9	56	5	4	6	51	10	17°28	16°62	... „
	9	55	43	4	6	29	5	...	...	249 59 „
24	10	11	17	4	26	3	20	13°29	12°78	... W. B.
	10	6	34	4	21	19	4	...	...	207 21 „
28	9	46	15	4	16	43	20	13°66	13°15	... „
	9	47	3	4	17	33	4	...	...	292 57 „
1898.										
Jan. 10	9	38	22	5	0	4	10	16°17	15°61	... L.
	9	30	12	4	51	53	4	...	...	240 16 „

Royal Observatory, Greenwich;
October 1900.

Corrections to the Armagh Catalogue for 1840.
By J. L. E. Dreyer, PhD.

Most of the corrections to the Armagh Catalogue given below are the results of an examination of the reductions of a number of stars made two years ago at the request of Professor Auwers. In addition to the ordinary arithmetical errors likely to occur in a vast amount of figure work, the Armagh star-places are not infrequently vitiated by errors for which the peculiar method of reduction adopted by Dr. Robinson is responsible. The right ascension of every star to be determined was taken from some catalogue (at first Piazzini or the A.S.C., later often the B.A.C.), brought up to the beginning of the year and reduced to apparent place, and this "assumed R.A." was then compared with the observed time of meridian transit. The result of this comparison was a clock error, and the difference between that and the clock error found by standard stars was adopted as the "correction to assumed R.A." of the star in question. Similarly in N.P.D. the comparison gave an "index error," the difference of which from the index error found by the nadir observation gave the "correction to assumed N.P.D." It is obvious that this roundabout way of reducing the observations gave abundant opportunities of

blundering. For instance, not a few errors were introduced by the computers, in the course of years, taking the assumed place of a star from different catalogues and then overlooking this when making up the final catalogue, so that the mean of the "corrections to assumed place" in some instances was applied to a star-place which was not that to which some of the individual corrections really corresponded.

In addition to the copious list of errata given at the end of the catalogue,* there is a further list at the end of the *Second Armagh Catalogue*, in which for No. 1035 read No. 1435, while the N.P.D. of the star is $31^{\circ} 29' 51''\cdot87$.

The following list contains all the corrigenda noticed since 1886 :—

No. 540. On p. 67, the single results in P.D. should be :

$$\begin{aligned} & \text{—}^{\circ}90 \\ & \text{—}1^{\circ}47 \\ & \text{+}^{\circ}33 \\ & \text{+}^{\circ}30; \end{aligned}$$

and the final N.P.D. is $82^{\circ} 15' 38''\cdot29$.

No. 576. On p. 71, the single results in R.A. should be :

$$\begin{aligned} & \text{+}^{\circ}12 \\ & \text{—}^{\circ}18 \\ & \text{—}^{\circ}06 \\ & \text{+}^{\circ}57; \end{aligned}$$

and the final R.A. should be $2^{\text{h}} 31^{\text{m}} 9^{\text{s}}\cdot60$.

No. 585. The result in P.D. on 1844 December 2 should be $+0''\cdot78$, and the final N.P.D. $41^{\circ} 27' 11''\cdot16$.

Nos. 1373, 1389. 36 *Camelop.* and *Radcliffe* 1661. The observer at the Mural Circle never saw more than one star. On 1840 March 5 and 1841 February 20 he certainly observed the preceding star, and on 1839 February 10, 1840 February 13, 1844 February 16, and 1851 January 2 he certainly observed the following one ; but on the other nights it is impossible to say which he observed, as he did not give the minute of P.D., and the stars differ nearly $1'$ in P.D. There seem to be no errors in the reductions.

No. 1945. ι *Canceri*. 1834 February 24, only *Procyon* and *Pollux* observed for time, and there must be some error in the observation of *Procyon*. The clock error taken from *Pollux* only

* It may seem superfluous to draw attention to this, but experience shows that astronomers frequently overlook lists of errata. Sir John Herschel, for instance, when preparing his *General Catalogue of Nebulae*, seems to have taken no notice of the errata given in his own Cape Observations.

agrees perfectly with the rate of the clock from February 23 and 25. Adopting this, we get for the stars observed this evening :

		Correction to Assumed Place. s	Final R.A. in Catalogue. s
1945	ι Cancri	+0'41	0'30
2406	χ Leonis	+0'34	45'67
2433	69 „	+0'05	34'03
2454	76 „	+0'45	42'15
2469	ι „	+0'54	34'73
2484	τ „	+0'20	42'37
2648	ε Virg.	+0'56	13'52

No. 2457. δ *Crateris*. Confusion in the assumed places in N.P.D. The mean result is $103^{\circ} 54' 47'' \cdot 54$.

No. 2507. Approximate P.D.= $19^{\circ} 50'$.

No. 2899. The first result in R.A. should be $+0^{\circ} 05$; final mean, $13^{\text{h}} 27^{\text{m}} 38^{\text{s}} \cdot 54$.

No. 3060. Minute of P.D. is $27'$.

No. 3240. ν^2 *Boötis*. Always hurriedly observed in R.A. after 52 *Boötis*.

No. 4003. Observed after 55 *Draconis* ; no estimate of N.P.D. given. According to Schröter, of Christiania (*A. N.* 3527), it is not on the parallel of 55 *Draconis*.

No. 4698. Seconds of N.P.D., $46'' \cdot 69$.

No. 4781. For single results, see p. 832.

No. 5003. Observation of 1838 November 11 (over one wire and through clouds) should be rejected. This makes seconds of R.A.= $58^{\text{s}} \cdot 11$.

No. 5175. Single results in N.P.D. should be $+2'' \cdot 75$ and $+5'' \cdot 30$, and N.P.D.= $67^{\circ} 28' 31'' \cdot 51$.

No. 5181. On p. 627, for $4'' \cdot 76$ read $+10'' \cdot 18$. Seconds of P.D. are $6'' \cdot 15$.

On the Variable Velocity of a Persei. By H. F. Newall.

From measurements which have been made of photographs recently taken at the Cambridge Observatory, it appears that a *Persei* has a variable velocity in the line of sight.

Eleven photographs were secured during 1900 September and October with the large four-prism spectroscope that was used in the observations of *Capella*. The spectra are taken with a long camera, and the linear dispersion is 6 tenth-metres per millimetre. The spectra are measured with a Zeiss micrometer, which is so arranged that ten revolutions of the micrometer screw correspond to 1 millimetre ; thus one revolution of the micrometer corresponds to 0'6 tenth-metre, and there is not much

difficulty in setting the wires on the lines of the photographed spectra with such precision as to give the wave-length of the lines within one-hundredth of a tenth-metre. In terms of velocity, one revolution of the micrometer corresponds to about 40 kilometres per second.

The following table contains a statement of the results obtained from the above-mentioned photographs. Each spectrum has been measured in the manner described in a previous paper (*Monthly Notices*, vol. lx. p. 418). The values given for the velocity are means of two measurements made, one by myself, the other by my assistant, A. W. Goatcher. There is a systematic difference of about 2 km./sec. between our results; this requires further investigation, but does not affect the broad facts established by the work as a whole.

Velocity of α Persei in the Line of Sight.

Plate Number		Velocity Relative to Earth.	Correction for Earth's Orbital Velocity.	Velocity Relative to Sun.
F. 118	1900 Sept. 6.54	-20.9	+24.8	+3.9
F. 121	Sept. 11.58	-26.4	+24.2	-2.2
F. 123	Sept. 13.48	-24.3	+23.9	-0.4
F. 125	Sept. 17.52	-22.2	+23.3	+1.1
F. 126	Sept. 19.52	-21.1	+22.9	+1.8
F. 128	Sept. 21.50	-16.9	+22.5	+5.6
F. 130	Oct. 4.46	-16.0	+19.3	+3.3
F. 131	Oct. 10.44	-15.4	+17.5	+2.1
F. 132	Oct. 21.44	-10.5	+13.6	+3.1
F. 134	Oct. 26.39	-4.2	+11.7	+7.5
F. 135	Oct. 27.41	-10.9	+11.3	+0.4

Three other photographs taken with half the linear dispersion were secured in 1899 October. They have been measured, with the following results:—

F. 23	1899 Oct. 5.46	-22.7	+18.9	-3.8
F. 26	Oct. 9.46	-15.5	+17.7	+2.2
F. 28	Oct. 10.44	-17.9	+17.4	-0.5

A preliminary discussion of the variable velocity leads me to alternative conclusions, between which it is not possible to decide until more material is collected. The conclusions are that α Persei may move either in an approximately circular orbit in a period of 4.20 days, or in an elliptical orbit of considerable eccentricity in a period of about 16.8 days.

The range of velocities observed at Cambridge is small, lying between -4 and +8 km./sec. The Potsdam observations in 1888 give a velocity of -10 km./sec. Professor Campbell's obser-

vations at the Lick Observatory are recorded in the *Astrophysical Journal*, vol. viii. p. 150 :—

1896	Nov. 11·8	...	...	...	—2·0
	Nov. 12·8	...	...	...	—1·8
1897	Jan. 19·6	...	...	...	—3·5
1898	July 12·0	...	...	...	—2·1

Curiously enough, the dates of the latter observations are so related as not to give decisive evidence as to which of the suggested periods is most probable.

More material is required, and it should be gathered in photographs taken at short intervals. I beg to present this note in the hope that other observers may be able to secure observations whilst *α Persei* is in favourable position.

1900 November 8.

On the Disappearance from Photographic Films of Star-images and their Recovery by the aid of a Chemical Process. By Isaac Roberts, D.Sc., F.R.S.

On p. 15 of my second volume of photographs of *Stars, Star-Clusters and Nebulae* I gave instances of the disappearance of the images of many faint stars from the films of negatives, which had been taken nine and a quarter and nine and one-fifth years respectively, between the dates when the images were counted. This statement was seen by Sir William Crookes, and he informed me that probably by the application of chemical reagents the images that had become invisible might be restored to view; and further he generously offered to try the experiment if I would send him the negatives; which offer, of course, I gladly accepted.

The two negatives referred to in my book were sent, and in a short time they were returned to me with the request that I should examine them and report if the experiment had succeeded. I thereupon recounted the star-images on the plates and found that every one of the missing images had been restored to view as distinctly, I think, as they were after the negatives were first developed; the experiment therefore had succeeded perfectly.

Sir William Crookes readily placed at my disposal the formulæ of the reagents he had employed in the experiment, with permission to publish them, thus placing me, and all others who may be engaged in the work of photographing the stars and nebulae, under obligation to him.

The following are the formulæ and processes employed by Sir William Crookes as they were given in his letter to me :—

- “1. Soak the plate for three hours in distilled water.
- “2. Prepare, in advance, two solutions, A and B.

SOLUTION A.

Pyrogallic acid . . . 1 oz.
Sodium metabisulphite 1 oz.
Water 80 oz.

SOLUTION B.

Sodium carbonate (crystals) 12 oz.
Sodium sulphite 4 oz.
Water 80 oz.

"Mix equal parts of A and B, and allow the plate to soak in the mixture for ten minutes or a quarter of an hour, in the dark. Wash well.

"3. Transfer the washed plate to a solution of 3 oz. of sodium hyposulphite in 20 of water. Allow it to remain for half an hour, and then wash the plate in running water for three hours.

"4. Prepare a 'Clearing' solution according to the following formula :—

Alum	1 oz.
Citric acid	1 oz.
Ferrous sulphate	3 oz.
Water	20 oz.

"Allow the plate to soak in this for ten minutes, and then remove and wash in running water for six hours.

"5. Prepare, in advance, two solutions, C and D.

SOLUTION C.

Ammonium sulphocyanide 100 gr.
Water 10 oz.

SOLUTION D.

Gold chloride . . . 15 gr.
Water 15 oz.

"For use take 1 oz. of each, and add 8 oz. of water. Soak the plate in this mixture for ten minutes, and at the end of the time remove and wash it in running water for half an hour. Transfer to a dish of distilled water, where it may remain for an hour. Finally drain on blotting paper and allow to dry.

"The separate solutions A, B, C, D will keep for an indefinite time, and the same may be said of the clearing solution, if kept tightly corked. But when mixed together they will not keep, so fresh mixtures should be made each time.

"I have given you the full process adopted on the plates you sent me, but I think some of them may be omitted with no disadvantage. For example, I should like to try if the soaking in hyposulphite may be dispensed with. I think it can, but I only tried leaving it out on the plates you sent that had not faded.

"I always found the great secret of preventing images from fading out was to wash them very well in running water. The clearing solution allows the time of washing to be a little shortened, but not much.

"The sulphocyanide and gold solution has the property of precipitating gold on the image, and rendering it of a blacker colour and diminishing the chance of fading. I should think

you would find it useful always to use the clearing solution and the sulphocyanide and gold solution in your usual process.

“(Signed) WILLIAM CROOKES.”

1900 July 6.

On the near Approach of the Planet Eros to a Star
(B.D. +48°, 759). By F. A. Bellamy.

The planet *Eros* is under regular photographic observation at the University Observatory, Oxford, for determining the parallax.

The plan of work adopted is to get several exposures as soon after sunset and as soon before sunrise as possible. It may be of interest to give a summary of plates at present taken. Fifty sets of exposures, either evening or morning, have been secured with an aggregate of 205 exposures, varying from 10^m to 30^s; on ten occasions pairs of parallax plates have been obtained (evening and morning). Since October 31 the weather has been very unfavourable, and only two plates have been exposed. All images of *Eros* and all the stars in the A.G. Catalogues of Harvard and Bonn which come within the area of the plates have been measured, and many of the plate constants determined provisionally. On October 12 the sky was thickly overcast until 8½ P.M. I came out of the Observatory a few minutes later and noticed a break in the clouds in the west, and decided to get the instrument ready in case a fine interval should come over; by 8.45 the sky was almost cloudless, and I secured 10 exposures on plates 1632 and 1633 within the next 50 minutes; 10 minutes later the sky was completely cloudy and remained so.

The chief point of interest in these two plates is the proximity of *Eros* to a star, since identified as B.D. +48°, 759. From the first to the fifth exposures the angular distance decreased, the planet moving north and west, until at the sixth and seventh exposures the images of star and planet are confused (see diagram, p. 18). The following measures were made by myself, using one of the Astrographic Catalogue measuring instruments, the unit adopted being 1 réseau interval of 5'.

Plates 1632 and 1633 Exposed 1900 Oct. 12. R.A. 2^h 42^m +49°.

Exp.	Mag.		Eros	☆	Eros-☆.	Eros y.	☆	Eros-☆.	Oxford Sid.
	Fros.	☆	x	x			y.		Time of Middle of Exposure.
									h m s
1	18	17	14.124	14.082	+ .042	10.966	11.057	- .091	22 6 12
2	15	15	.116	.077	+ .039	.895	10.970	- .075	11 22
3	20	20	.114	.080	+ .034	.812	.874	- .062	16 27
4	19	19	.106	.079	+ .027	.731	.778	- .047	21 46
5	16	17	.100	.075	+ .025	.649	.679	- .030	25 57
6	21?	22?	.062	.049	+ .013	.939	.942	- .003	36 12
7	18?	20?	.060	.050	+ .010	.849	.838	+ .011	41 2
8	16	19	.055	.046	+ .009	.758	.733	+ .025	45 27
9	14	18	.050	.047	+ .003	.651	.619	+ .032	49 2
10	10	13	14.046	14.042	+ .004	10.562	10.516	+ .046	22 52 42

The measures of the 6th and 7th exposures are not very satisfactory owing to the coalescent images.

The motion in x , between the 1st and 10th exposures, is $\cdot 038$ in $46^m \cdot 5$ and in y $\cdot 137$, being equivalent to $\cdot 00082$ in x , and $\cdot 00295$ in y for 1^m . If the epoch of nearest approach be adopted as $22^h 37^m 10^s$, the following results are obtained :—

Time of Exposure from Epoch. m	Planet's Motion.	Measured x .	Sum.	Planet's Motion.	Measured y .	Sum.
-31 ^o 0	- ^o 025	+ ^o 042	+ ^o 017	+ ^o 091	- ^o 091	^o 000
-25 ^o 8	- ^o 021	+ ^o 039	+ ^o 018	+ ^o 076	- ^o 075	+ ^o 001
-20 ^o 7	- ^o 017	+ ^o 034	+ ^o 017	+ ^o 061	- ^o 062	- ^o 001
-15 ^o 4	- ^o 013	+ ^o 027	+ ^o 014	+ ^o 045	- ^o 047	- ^o 002
-11 ^o 2	- ^o 009	+ ^o 025	+ ^o 016	+ ^o 033	- ^o 030	+ ^o 003
- 1 ^o 0	- ^o 001	+ ^o 013	+ ^o 012	+ ^o 003	- ^o 003	^o 000
+ 3 ^o 9	+ ^o 003	+ ^o 010	+ ^o 013	- ^o 011	+ ^o 011	^o 000
+ 8 ^o 3	+ ^o 007	+ ^o 009	+ ^o 016	- ^o 024	+ ^o 025	+ ^o 001
+11 ^o 9	+ ^o 010	+ ^o 003	+ ^o 013	- ^o 035	+ ^o 032	- ^o 003
+15 ^o 5	+ ^o 013	+ ^o 004	+ ^o 017	- ^o 046	+ ^o 046	^o 000

[1 unit = $300''$, or $0\cdot001 = 0''\cdot3$.]

This seems to show that the adopted time of nearest approach is very near the actual time.

The position of the star (B.D. $+48^\circ$, 759) for 1900^o0 is R.A. $2^h 41^m 26^s \cdot 2$, and Dec. $+48^\circ 51' 22'' \cdot 8$; this is determined from measures on plate 1632.

The mean measured diameter from the 10 exposures is $16\cdot7$ for *Eros* and $18\cdot0$ for the star; the star is given as $9\cdot5$ in B.D., so *Eros* was slightly fainter, probably $9\cdot7$ or $9\cdot8$; but scarcely so faint as the photographic magnitude assigned by Dr. Millosevich ($10\cdot9$)—more nearly accordant with his visual magnitude ($9\cdot9$).

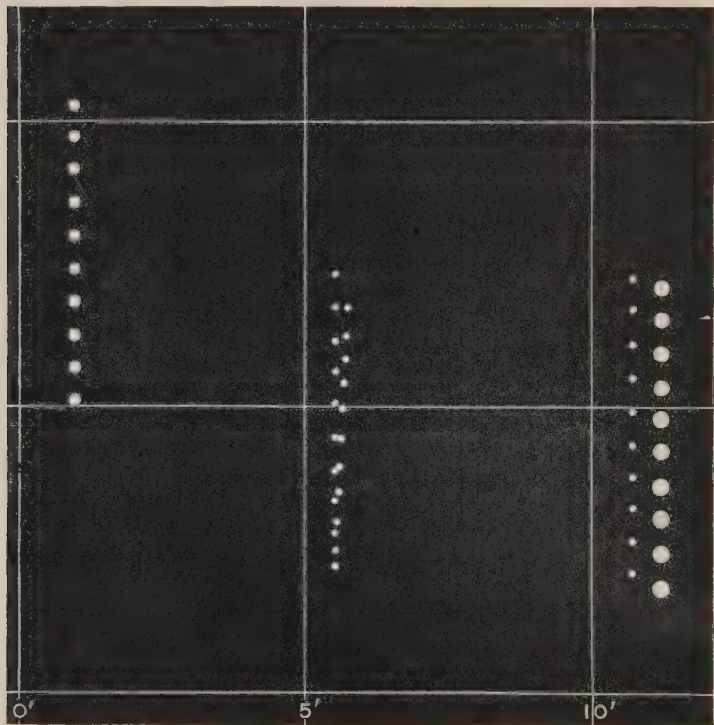
The most accurate ephemeris of the planet yet published is that given by Dr. Millosevich in *Astron. Nachrichten*, Nos. 3660, 3661, 3662. From comparisons with 5 plates the following corrections to this ephemeris have been found, assuming that the R.A. and Dec. given are referred to the true equinox of date.

Date.	Hour Ang'e.	Correction to Ephemeris.	
1900.	h	"	"
Sept. 19	$4\frac{1}{2}$ East	- 0 ^h 87	+ 0 ^h 6
Oct. 5	$6\frac{1}{2}$ „	- 1 00	+ 0 8
5	3 West	- 0 ^h 92	+ 2 ^h 4
12	$4\frac{1}{2}$ East	- 1 ^h 31	+ 0 ^h 6
15	4 West	- 1 ^h 30	+ 0 ^h 5
28	5 „	- 1 ^h 46	+ 0 ^h 2

The reductions are entirely provisional, and may be slightly in error, e.g. on Oct. 5, though they have been examined. The

ephemeris published by Mr. Frank Robbins* is accordingly in error in R.A. by about $5''$ on Sept. 19 and $14''$ on Oct. 28; and in Dec. by about $1'$.

Eros is now moving in a part of the sky where there are about 25 stars per square degree† shown on the B.D. charts. The total length of track in the seven months, September to March, is about 70° ; and if we take a width of $5''$ on each side, or $10''$ altogether, the area covered by this path is $70/360$, or 0.2



Eros is the image to the right of the central pair; the first exposure is at the top; motion north and west. Scale $7\frac{1}{2}$ times the original negatives.

square degree, which should thus contain 5 stars. An approach to some star of the B.D. within $5''$ should thus take place about once in 6 weeks on the average. By securing photographs beforehand we could perhaps predict these approaches, which would afford good opportunities for micrometric measures.

* *Monthly Notices*, lx. p. 614.

† See diagram, *Monthly Notices*, lx. Plate 2.

Observations of Jupiter and his Satellites made at Mr. Crossley's Observatory, Bermerside, Halifax, during the Opposition 1899-1900. By Joseph Gledhill.

Owing to the low altitude of the planet and the bad observing conditions prevailing in the winter and spring of 1899-1900 very few observations could be made. On no occasion was the air steady enough for micrometer measures, and it was but seldom that a good view of the planetary details could be obtained. The structure of the North Tropical Belt was never really well seen; and unfortunately the details and changes of this belt have been for some years among the most interesting features of the planet. As in previous papers, the nomenclature used is that of the British Astronomical Association.

It may perhaps be worth noting that in the diagram on p. 45 of vol. lx. of the *Monthly Notices* the band numbered 1 should be single, not double. This band has for some years been a single straplike band.

The 9-inch Equatorial Refractor (photo-visual), by Messrs. Cooke, of York, was the instrument used. No power higher than 240, and that rarely, was ever used.

The Southern South Temperate Band.

This band always appeared a faint one, but on several occasions it was broader than the S. Temperate Band, *e.g.* May 15, 11^h; July 3, 9^h. At 8½^h July 26 it was noted as a narrow band. It was never an easy object, and was perhaps never really well seen.

The South Temperate Band.

This is the grey band so often described as *straplike* in previous papers. In some longitudes it appeared faint, in others a fairly strong grey band—*e.g.* it was faint at 10½^h May 24, faint and narrow at 9^h July 3, faint at 9^h July 10, and at 8^h July 17; it was narrow and well seen at 8½^h July 18, narrow at 8½^h July 26 and at 7^h 40^m August 15. It was described as "a well-marked band" at 9¼^h July 17. In some longitudes it was broad and in others narrow, and the place where it changed from broad to narrow was seen on one or two occasions. The place where it changed from a faint to a darker band was on or near the central meridian at 9^h 5^m July 16, the darker portion being the western.

The South Tropical Belt.

This is the fine, double, dark belt, just S. of the equator. As in many past oppositions, so in this, its N. component has had many dark spots on its N. edge. As in past years, too,

the S. component has exhibited the well-known *p* shoulder, *f* shoulder, and the fainter portion of the belt preceding the *p* shoulder. In some longitudes (*e.g.* May 15 at 11^h) the N. component was the darkest band on the disc; in others both components were together fainter than the double band just N. of the equator (North Tropical Belt)—*e.g.* May 24, 10 $\frac{1}{2}$ ^h, and at 9^h July 10. In some longitudes the components are well separated—*e.g.* June 17, 9 $\frac{1}{2}$ ^h; in others they are almost in contact. The upper (S.) component was the darkest band on the disc at 9^h July 3. On July 10, 9^h, the two bands were well separated along the *f* half. On July 18, 8 $\frac{1}{2}$ ^h, this southern double band was wider and darker than the N. Tropical Belt, much darker at 8^h 20^m August 15, and wider on August 16, 7^h.

The North Tropical Belt.

This fine, double, dark band has in some longitudes lost some of its depth of tone since the last opposition. On the other hand it has decidedly gained in warm colour. During the late opposition I was never able to see its intricate structure well. The colour just mentioned was strikingly seen at 10 $\frac{1}{2}$ ^h May 24. On July 16, 9^h, the western half was darker than the eastern half. The numerous bright and dark spots on it were often seen, but rarely well enough for clear description or transit observations. The band as a whole has lost its old sharpness.

The North Temperate Band.

A faint band was often seen in this region.

The Central or Equatorial Zone.

Most of the warm colour has left this zone; indeed, it differs very little in point of colour from the rest of the disc.

The brightest zone was always that between the South Tropical Belt and the South Temperate Band.

The Red Spot was not seen on any occasion, owing, no doubt, to the low altitude of the planet and the violent motion.

The faint, narrow, and often interrupted band in the Equatorial Zone was often seen—*e.g.* May 24, 10 $\frac{1}{2}$ ^h; June 17, 9 $\frac{1}{2}$ ^h; July 3, 9^h; July 16, 9^h; July 18, 8 $\frac{1}{2}$ ^h; August 15, 7^h 40^m.

Bright and Dark Spots.

Dark spots under the South Tropical Belt were seen on perhaps every night when the planet was visible; and some were seen on the North Tropical Belt. Some bright spots also were seen. Few transits of any value could be obtained owing to the great motion.

July 1, 9^h. A large, bright spot seen under (to N. of) the S. Tropical Belt; on central meridian about 9^h.

July 16, 9^h 14^m. A bright gap in the S. Temperate Band was on central meridian.

July 17. Two bright spots or gaps were seen in the N. component of the S. Tropical Belt. One was on the central meridian about 9^h 17^m. A dark spot on the N. component of the N. Tropical Belt was on the central meridian about 9^h 21^m.

July 18. At about 9^h 2^m a bright spot or gap in the S. Temperate Band was on the central meridian.

August 15. At about 8^h 8^m a dark spot on the N. edge of the N. component of the S. Tropical Belt was on the central meridian. Two bright gaps in the N. Tropical Belt were also seen. One of them was on the central meridian about 8^h 17^m.

August 16. A long, dark spot on the N. edge of the S. Tropical Belt was on the central meridian about 7^h 43^m. A bright gap in the S. Temperate Band was seen about the same time to the W. of the central meridian.

August 20. Two bright gaps were seen in the N. Tropical Belt at 7^h 24^m.

August 27. A bright gap in the N. component of the N. Tropical Belt was central about 8^h 8^m. A little in advance there was another bright gap in the same belt.

Phenomena of Jupiter's Satellites.

II. Tr. I. External contact at 8^h 54^m July 10; visible on the disc till after 9^h 20^m. I. Ec. R. First seen, through thin cloud, at 10^h 25^m 44^s July 12. III. Sh. I. Just fully on the disc at 8^h 43^m July 17.

II. Oc. R. External contact at 7^h 27^m, and II. Ec. D. last seen at 7^h 38^m 0^s August 20.

On the Appearance of Saturn's "Crape" Ring in 1900.

By E. M. Antoniadi.

Since the publication of the two papers in vol. lix., pp. 498 and 586, of the *Monthly Notices*, the writer has tried to follow the development of the dark ring as affected by the varying heights of the Sun and Earth above the plane of the system.

Owing to the fact that the mirror of the great Paris siderostat could not be pointed so as to make a smaller angle than 12° with the vertical, observations of *Saturn* at $-22\frac{1}{2}^{\circ}$ of declination were rendered impossible with the large telescope. At Juvisy, with the 9 $\frac{3}{4}$ -inch equatorial, nothing abnormal could be detected until the beginning of autumn. On 1900 October 2 the following peculiarities were noted again and again during the fugitive moments of very sharp seeing:—

1. The "crape" ring seemed of uniform intensity across the planet.

2. Its breadth on minor axis was greater than what ought to be expected from its breadth on major axis ; indeed, along the minor axis, it appeared broader than the outermost ring, occupying fully three-tenths of the total breadth of the system.

3. Its inner edge in front of *Saturn* was much more concave than the outer edge ; more so than would be anticipated from the divergence of two concentric elliptical arcs. Meantime, the inner edge across the planet did not seem to form the continuation of the edge projected on the sky. But this observation was rendered exceedingly difficult and uncertain on account of the low altitude of *Saturn* and the concomitant strong absorption of the "dark" ring's feeble light.

Now, at the date of these observations we had

$$l-l' = 0^{\circ}43',$$

a value which, taken in connection with the facts enunciated, tends to militate against the notion of a *dark* ring. Owing, however, to the smallness of $\Delta = 43'$, these results cannot be considered decisive, almost grazing, as they do, observational errors. The question will be elucidated by the greater values of Δ in coming years.

Observatoire Flammarion, Juvisy (S.-et-O.):
1900 October 12.

Occultations of Saturn, 1900 June 13 and September 3, observed at the Radcliffe Observatory, Oxford.

(Communicated by the Radcliffe Observer.)

The following observations of two occultations of *Saturn* were made at this Observatory :—

1900 June 13.

Phenomena.	Observer.	Reappearance (at Dark Limb of Moon). Observed G.M.T.		
		h	m	s
<i>Ring—</i>				
1st trace	R.	10	49	51.1
2nd contact	"	10	50	1.6
<i>Ball—</i>				
1st contact	"	10	50	20.0
<i>Ring—</i>				
3rd contact	"	10	51	3.9
Last "	"	10	51	11.9

Observer's Remarks.

Saturn very faint ; reappeared near bright, but defective,

limb of the Moon. Observations made with the Barclay Equatorial, using power 90.

1900 September 3.

Phenomena.	Disappearance (at Dark Limb of Moon). Observed G.M.T.					Reappearance (at Bright Limb of Moon). Observed G.M.T.					Reference to Re- marks.
	A.	A.	R.	W.	B.	A.	A.	R.	W.	B.	
<i>Ring—</i>	h	m	s	s	s	h	m	s	s	s	
1st contact	7	12	...	50.2	50.4	8	8	50.8	57.3	49.2	(a)
2nd „	7	12	...	58.5	56.9	8	8	54.8	63.1	55.2	
<i>Ball—</i>											
1st contact	7	13	2.5	2.9	1.9	8	9	7.3	10.0	3.1	(b)
Bisection	7	13	...	24.3	...	8	9	...	32.2	...	
Last contact	7	13	56.4	57.3	54.2	8	9	41.2	47.9	33.1	
<i>Ring—</i>											
3rd contact	7	14	12.4	10.7	12.7	8	9	45.2	56.5	36.6	(c)
Last „	7	14	31.3	31.0	30.1	8	9	57.2	62.4	59.0	(d)

Observers' Remarks.

Disappearance:—

[A. A. R.] Thin cloud throughout. (b) Doubtful. (c) Possibly 1^s too early.

[W.] Observation very difficult, made through hazy cloud. No satellites visible. The points observed are those where the major axis of the ring would cut the ring and ball.

[R.] Images diffused; sky hazy. Observations difficult. (a) May be 1^s late. (b) A lingering contact.

Reappearance:—

[A. A. R.] (a) Likely to be good, as attention was concentrated at the very point of limb where planet reappeared. (c) May be a little too soon. The colour of ring and ball appeared much greyer than that of the Moon.

[W.] (a) Was looking exactly at place of reappearance. The light of *Saturn* looked ashy grey compared with the yellow disc of the Moon. The limbs of planet and Moon were much steadier than at disappearance. As the planet emerged obliquely, the same points along the axis of the ring were observed as at disappearance. After emergence, the major axis of *Saturn's* ring, when produced to cut the limb of the Moon, formed with a tangent to the Moon's limb (drawn at the point of intersection) an angle of about 30°.

[R.] Observations difficult. (a) Ring faint, but first trace caught. This observation considered satisfactory. (d) Contact lingered. Part of the ring appeared to be thinly veiled by a narrow band of shade adjacent to the Moon's limb.

[Note added later.—(c) The observer considers his observation of the 3rd contact of ring entitled to but little weight.]

At reappearance, both A. A. R. and R. have, for the 1st and 2nd contacts with the ring and for the 1st contact with the ball, observed the moment at which any part of the outline of ring or ball first emerged from behind the limb of the Moon; and for the 2nd contact with the ball and the 3rd and 4th contacts with the ring the first moments at which the limb of the Moon and the outline of the ring or ball were completely separated; whereas W. noted the times of emergence of the several points where the major axis of the ring cut the ring and ball.

Observers (September 3):—

[A. A. R.] Dr. Rambaut. Barclay equatorial, 10-inch aperture. Powers: 180, disappearance; 85, reappearance.

[W.] Mr. W. Wickham. Marlborough telescope, 3'2-inch. Power, 75. Observations recorded on the chronograph.

[R.] Mr. W. H. Robinson. Helimeter, 7'5-inch (one segment only). Powers: 200, disappearance; 80, reappearance.

Radcliffe Observatory, Oxford:
1900 November 6.

Occultation of Saturn, 1900 September 3. By the Rev.
S. J. Johnson, M.A.

The occultation of *Saturn* on this evening took place under similar circumstances to that which I witnessed on 1870 September 30, the sky being on both occasions singularly clear, the disappearance being about half an hour after sunset, the Moon not far from the first quarter, and the objects nearly at the same point in the sky.

I employed power of 100 on $3\frac{3}{4}$ -inch equatorial.

At 7^h 10^m 17^s the preceding ansa of the ring already in contact with the Moon's limb.

7^h 11^m 1^s. Globe of *Saturn* reached.

7^h 11^m 54^s. Globe covered.

7^h 12^m 30^s. Following ansa of ring immersed.

At the reappearance, owing to the dull faint colour of the planet, it had begun to come out a few seconds before being distinctly perceived.

At 8^h 6^m 53^s. Globe began to emerge.

8^h 7^m 40^s. Globe entirely emerged.

8^h 7^m 59^s. Last contact with following ansa of ring.

The planet disappeared gradually with uniform motion, and clear definition. At emersion, the difference of brilliancy between the bright yellow limb of the Moon and the grey disc of the planet was most striking. One could not but be impressed with the marked contrast with the brightness of *Jupiter* when close to the Moon at his occultation four years ago last June.

Melplash Vicarage, Bridport:
November 2.

Photographic Measures of the Ring Nebula in Lyra and of the Neighbouring Faint Stars. By F. P. Leavenworth.

(Communicated by the Secretaries.)

In response to Professor Barnard's request for observations of the faint stars near the Ring Nebula of *Lyra* (see *Monthly Notices, R.A.S.*, January 1900), the following measurements are published. They are measures of photographs taken with the 10½-inch refractor of the University of Minnesota.

Observations of position-angle and distance were made with a Repsold measuring machine, exactly as a double star is measured with a filar micrometer or an ordinary visual telescope. Each measure was repeated with the angle rotated through 180°.

The orientation was found by reading the angle of a star trail on the plate.

Since the distances measured were very small, never more than one and one-half millimetres, variation of scale value and other small corrections were found to be negligible quantities. The amount of time consumed in measurement and reduction was therefore not greatly in excess of that employed in ordinary double-star measures.

Corrections were applied for division error of scale, error of run and refraction. In addition a correction to the reading of the circle for orientation had to be introduced because the trail was not at the middle of the plate. If c = this correction and d = the distance of the trail from the middle of the plate,

$$c = d \tan \delta$$

plus if the trail is east. The greatest value of c was about 0°·5.

The adopted scale value for all four plates was one millimetre = 59''·64.

The plates were taken as follows :—

		h	m	
I. Sept. 1, 1897	Exposure	1	23	Night poor.
II. Nov. 1, 1899	"	2	4	" fair.
III. Apr. 1, 1900	"	1	42	" good.
IV. June 5, "	"	2	5	" good.

The nucleus of the nebula was a clearly defined spot which could be accurately measured. Star b was too indistinct to be observed except on plate 2, and c was scarcely stronger ; f could not be accurately measured on account of the blurring of the components.

Plate III. was measured by three members of the class in astronomy, Miss Harriet Dunton, Miss Louise Goulding, and Mr. Albert Lehman. Their names are indicated by the initials D., G., L. This being their first experience in photographic

measurements, each made a complete set of measures of the same plate. For this reason the separate results are given; and also to show what accuracy may be expected from measures repeated on the same plate. Plates I., II., and IV. were measured by myself.

The probable errors are $\pm 0^{\circ} \cdot 14$ and $\pm 0'' \cdot 18$ for the values of a position-angle and distance from a single plate.

Measures of Plate III.

Nucleus and <i>a</i> .			<i>a</i> and <i>d</i> .		
D.	88° 98	60'' 65	D.	286° 47	137'' 18
G.	89° 24	60° 30	G.	286° 47	137° 66
L.	89° 54	59° 76	L.	286° 44	137° 46

Nucleus and <i>d</i> .			<i>a</i> and <i>e</i> .		
D.	299° 38	82° 07	D.	292° 82	122° 25
G.	299° 47	81° 93	G.	292° 76	122° 25
L.	299° 70	81° 57	L.	292° 75	122° 29

Nucleus and <i>e</i> .			<i>a</i> and <i>g</i> .		
D.	312° 88	71° 71	D.	350° 76	75° 78
G.	313° 25	71° 71	G.	350° 62	77° 02
L.	312° 57	70° 85	L.	350° 39	76° 64

Nucleus and <i>g</i> .			<i>a</i> and <i>h</i> .		
D.	32° 72	90° 27	D.	148° 47	70° 45
G.	33° 13	90° 25	G.	148° 69	70° 60
			L.	148° 50	70° 56

Nucleus and <i>h</i> .		
D.	121° 08	113° 70
G.	121° 50	113° 93

Nucleus and *a*.

1897° 671	89° 48	60'' 42
1899° 837	89° 35	60° 83
1900° 248	89° 25	60° 24
1900° 428	89° 10	60° 73
1899° 55	89° 29	60° 56

Nucleus and *b*.

1899° 837	186° 61	65° 17
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Nucleus and *c*.

1899° 837	268° 12	55° 12
1900° 428	269° 53*	55° 56*
1900° 13	268° 82	55° 34

* Image double.

Nucleus and *d*.

1899·837	299 ⁰ ·86	81 ^{''} ·74
1900·248	299·52	81·86
1900·428	299·95	82·31
1900·17	299·78	81·97

Nucleus and *e*.

1897·671	312·62	71·66
1899·837	313·04	71·16
1900·248	312·90	71·32
1900·428	312·65	71·12
1899·55	312·80	71·32

Nucleus and *g*.

1899·837	32·49	89·59
1900·248	32·72	90·26
1900·428	32·10	90·53
1900·17	32·50	90·13

Nucleus and *h*.

1897·671	121·12	113·67
1899·837	121·08	114·12
1900·248	121·29	113·82
1900·428	121·23	113·74
1899·55	121·18	113·84

a and *b*.

1899·837	225·57	94·38
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a and *c*.

1899·837	268·63	115·38
1900·428	268·63	115·72
1900·13	268·63	115·55

a and *d*.

1899·837	286·90	137·14
1900·248	286·46	137·43
1900·428	286·91	137·74
1900·17	286·76	137·44

a and *e*.

1897·671	292°60	122"88
1899·837	292°88	122"14
1900·248	292°78	122°26
1900·428	292°57	122°20
1899·55	292°71	122°37

a and *g*.

1899·837	350°14	76°12
1900·248	350°59	76°48
1900·428	350°22	76°78
1900·17	350°32	76°46

a and *h*.

1897·671	148°54	70°41
1899·837	148°70	70°50
1900·248	148°56	70°54
1900·428	148°57	70°24
1899·55	148°59	70°42

Considering the great difference in the size of the telescopes, in the methods used, and in the difficulty of the objects measured, the agreement with Professor Barnard's measures is very good, and confirms his results. There is without doubt a difference of 1°·4 and 1'' between Burnham's measures of the nucleus and *a* and the present value. And it seems very probable that there is motion in one of these objects.

The complete list of measures of nucleus and *a* are as follows :—

Burnham	1891·45	87°8	61°69	5
Scheiner	1894·83	89°07	60°85	1
Barnard	1898·60	88°77	60°70	5
"	1899·48	89°14	60°66	5
Leavenworth	1899·55	89°29	60°56	4

In a letter to the writer Professor Barnard has corrected the values of his distances, having obtained a better value of a revolution of the micrometer screw; and in Dr. Scheiner's measure I have, at Professor Barnard's request, used only the measure made by the former.

The magnitudes of the stars were determined by the sequence method. When compared with Professor Barnard's values

(*Monthly Notices* vol. lx. p. 248), and reduced by them to magnitudes, a very close agreement is obtained, as appears below :—

Star	Step.	Mag. B.	Mag. L.
<i>a</i>	0	12.2	12.2
<i>b</i>	25	12.8	13.1
<i>n</i>	27	...	13.1
<i>c</i>	28	13.2	13.2
<i>f</i>	40	13.7	13.6
<i>g</i>	43	13.7	13.7
<i>d</i>	44	13.5	13.8
<i>e</i>	49	14.0	14.0
<i>h</i>	52	13.8	14.1

University of Minnesota, Minneapolis :
1900 September.

*Observations of Nebulæ made at the Chamberlin Observatory,
University Park, Colorado. By Herbert A. Howe.*

(Communicated by the Secretaries.)

The accompanying notes on nebulæ are a by-product of the series of measurements made with the Bruce micrometer on the 20-inch equatorial refractor, during the twelve months ending 1900 June 30. They are corrections of or additions to our previous information, and form a continuation of the notes published in former numbers of the *Monthly Notices*, the last being in the issue for 1899 December. When the position of a nebula is given below it is to be understood that the position previously published in the N.G.C. or *Index Catalogue*, or in some later list sent out by the discoverer, is erroneous by at least ten seconds in right ascension or two minutes in declination. Usually the errors are much larger than these. All positions are referred to the mean equinox of 1900.0.

It has seemed best to divide the nebulæ mentioned into three lists. The first contains those found in the N.G.C., arranged in the order of their current numbers. The second list is made up from the *Index Catalogue*. All nebulæ taken from it have their current numbers enclosed in brackets, to distinguish them from those in the N.G.C. The third list consists of nebulæ found by Swift at the Lowe Observatory in recent years. All but one of them are found in *A.N.* 3517, and are designated by affixing their current numbers in that publication to the word Swift. The one exception, which I have called "Swift 12, 3," is taken from the *Monthly Notices*, vol. lix. No. 10, p. 568. The words "minutes" and "seconds" refer to time only. A few of the notes are about clusters which have been examined.

Nebulæ from the N.G.C.

- 17 and 34. I was unable to find 17 in the N.G.C. position for it, though, according to its description by Müller, it should not be difficult with my telescope. I judge it to be identical with 34, which follows two minutes at nearly the same declination. Müller says of 17 "D * 2' p," which is true of 34, which follows a double 8 seconds, 0'11 south. The double is of mags. 10-11, angle 280° , and distance 6". There is no double near the N.G.C. place for 17, except two faint stars about 50" apart. The position of the nebula is $0^h 6^m 0^s$, $-12^\circ 39'7$.
45. The "L * cont. f" is of mag. 9. There is a star of mag. 7 about 5' south preceding the nebula. The N.G.C. right ascension is ten seconds too small.
64. The position is $0^h 12^m 24^s$, $-7^\circ 22'8$.
65. The position is $0^h 13^m 56^s$, $-23^\circ 26'1$.
66. The " * 9 n 1" follows the nebula 1 second, 1'5 north. The position of the nebula is $0^h 14^m 2^s$, $-23^\circ 29'5$.
77. This may be simply an extremely faint star. The " * 9 p 3" appears to be of mag. 10, and precedes 13 seconds, 0'6 north. The position of the nebula is $0^h 14^m 59^s$, $-23^\circ 5'2$.
100. This is 2' long, and very narrow, the elongation being at 225° . It contains some condensations, but the moon was too bright at the time of observation to allow me to locate them definitely.
- 142, 143, and 144. The N.G.C. calls each "e F," the first two "S," and 144 "v S." The facts are that 144 is the brightest and largest, 143 next in size and brightness, and 142 faintest and smallest. Their positions are :—

			^h	^m	^s	[°]	[']
142	...	...	0	26	8,	-23	10'2.
143	...	...	0	26	16,	-23	6'7.
144	...	...	0	26	20,	-23	11'8.

150. One spot near the north preceding end of this pretty large nebula is brighter than the rest. The position of this spot is $0^h 29^m 18^s$, $-28^\circ 21'2$.
161. The discoverer says "nearly bet. 2 st." The stars are of mags. 8 and 9.5 respectively. A sketch shows that the first is about 6' north preceding the nebula, while the second is south following at a distance of 4' or 5'. I noticed another nebula 2' south of 161. The position of 161 is $0^h 30^m 28^s$, $-3^\circ 23'9$.
166. The " * 11 np" seemed to me to be of mag. 10, and preceded 17 seconds, 2'8 north. The position of the nebula is $0^h 30^m 47^s$, $-14^\circ 9'7$.

167. The position is $0^h 30^m 24^s$, $-23^\circ 55'6$.
168. The " $\ast 10\text{ nf }3'$ " is $2'5$ north, and follows 7 seconds.
The position of the nebula is $0^h 31^m 40^s$, $-23^\circ 8'6$.
172. There is a star of mag. 13 close south preceding. The position of the nebula is $0^h 32^m 15^s$, $-23^\circ 8'3$.
177. Müller queried whether this were a star. It seemed to me to be a nebula.
179. The " $B \ast np$ " is of mag. 8.5, and precedes a few seconds, about $5'$ north. The position of the nebula is $0^h 32^m 46^s$, $-18^\circ 23'9$.
187. The position is $0^h 34^m 29^s$, $-15^\circ 12'3$.
190. The " sev. st nr sp " are all of less than mag. 10. There is one of mag. 12.5 which lies about $30''$ due south of the nebula. Had the Moon been absent at the time of observation, perhaps the nebula would have been seen to extend to this star.
235. The nucleus of this is of mag. 11, so that it is favourable for measures of parallax. A star of mag. 9 lies $3'5$ north, a fraction of a second preceding.
276. Instead of a " $\ast 11\text{ n }3'$ " I find one of mag. 8, a close double, $4'$ or $5'$ (by a sketch) north following. There is a star of mag. 11, which is $3'0$ south, 6 seconds following.
The position of the nebula is $0^h 47^m 12^s$, $-23^\circ 13'3$.
320. The " $\ast 10\text{ n}$ " precedes 2 seconds, $1'3$ north. The position of the nebula is $0^h 53^m 52^s$, $-21^\circ 22'8$.
335. The position is $0^h 54^m 24^s$, $-18^\circ 46'4$.
363. The position is $1^h 1^m 19^s$, $-17^\circ 4'7$.
369. The position is $1^h 0^m 13^s$, $-18^\circ 17'7$.
417. The position is $1^h 6^m 11^s$, $-18^\circ 40'8$.
487. The position is $1^h 17^m 2^s$, $-16^\circ 53'5$.
554. The " $\ast 11\text{ f}$ " follows 8 seconds, $0'3$ north. The position of the nebula is $1^h 22^m 23^s$, $-23^\circ 14'6$.
555. The position is $1^h 22^m 25^s$, $-23^\circ 16'8$.
556. This is fainter than 555, which in turn is fainter than 554; the three are close together. The position of 556 is $1^h 22^m 26^s$, $-23^\circ 14'9$.
580. The position is $1^h 25^m 36^s$, $-2^\circ 30'5$.
583. The position is $1^h 24^m 53^s$, $-18^\circ 51'3$.
648. The position is $1^h 33^m 50^s$, $-18^\circ 20'3$.
655. The position is $1^h 37^m 1^s$, $-13^\circ 35'2$.
667. Müller says " $\ast 10\text{ np }100''$." It precedes the nebula 5 seconds, $0'8$ north. The nebula differs very little in appearance from a star of mag. 13.5. Its position is $1^h 40^m 14^s$, $-23^\circ 25'1$.
701. The elongation is at 210° .
725. The position is $1^h 47^m 47^s$, $-17^\circ 0'6$.
756. The position is $1^h 49^m 41^s$, $-17^\circ 11'9$.
836. The position is $2^h 5^m 47^s$, $-22^\circ 31'5$.
837. The position is $2^h 5^m 39^s$, $-22^\circ 54'3$.
849. The discoverer says " $? \text{neb.}$ " The object is as bright as

a star of mag. 12, and appeared to me a trifle un-starlike. I could see nothing else which appeared nebulous in the neighbourhood.

856. The "F * close f" is of mag. 11, and follows 3'5 seconds, 0'3 north.

858. The position is $2^h 7^m 53^s$, $-22^\circ 56'4$.

859. This is near 856 and 868, both of which are called "e F" by their discoverer, while 859 is called "p F." Yet, on the night on which I measured both 856 and 868 I was utterly unable to find their supposed brighter neighbour 859. Swift discovered 859 and 868 on the same night.

863. This contains a small nucleus of mag. 12, which is much brighter than the circumjacent nebulous matter.

866. This, like 859, I could not see on the night when I measured its supposably much fainter neighbours 856 and 868. Swift discovered 866 and 868 on the same night.

878. The position is $2^h 13^m 19^s$, $-23^\circ 50'7$.

899. The "D * p" is composed of two stars of mag. 10'5, widely separated. The nearer of the two precedes the nebulae 5^s , 0'9 south.

908. The nucleus is of mag. 13.

966. The " * 9 s p 2'" is of mag. 9'5, and precedes 1 second, 0'6 south. The position of the nebula is $2^h 27^m 10^s$, $-20^\circ 19'5$.

1034. The N.G.C. right ascension seems to be a minute out. The discoverer says "2 B st p 20s." In that place I see two stars of mags. 11 and 12. The position of the nebula is $2^h 33^m 30^s$, $-16^\circ 14'4$.

1098. This has a good nucleus of mag. 12'5. The position is $2^h 40^m 13^s$, $-18^\circ 4'9$.

1099. The position is $2^h 40^m 38^s$, $-18^\circ 7'8$.

1100. The position is $2^h 40^m 56^s$, $-18^\circ 6'6$.

1103. The " * 11 f" follows $1'5^s$, 0'2 north. Another similar nebula precedes this nebula 2^s , 2'0 south.

1105. I found nothing in the N.G.C. place for this, but 4^m following was a very small nebula, about equal in brightness to a star of mag. 13. As Leavenworth observed his nebula only once, and took its place roughly, the two may be identical. The position is $2^h 47^m 36^s$, $-16^\circ 7'1$.

1119. The position is $2^h 43^m 38^s$, $-18^\circ 24'2$.

1120. The position is $2^h 44^m 20^s$, $-14^\circ 53'2$.

1140. This very small object is about equivalent in brightness to a star of mag. 10.

1148. This has a sharp nucleus of mag. 13.

1163. The position is $2^h 55^m 44^s$, $-17^\circ 32'9$.

1182 and 1205. The descriptions of these given by their discoverer in No. 146 of the *Astronomical Journal* agree closely, except in regard to the angle of elongation. Their rough right ascensions there given differ 3^m . Having

examined the locality very carefully on two fine nights I judge the objects to be identical. The " $\star 9.5\ 3'$ sp" precedes 8^s , about $2'$ south. The position of the nebula is $2^h\ 58^m\ 38^s$, $-10^\circ\ 3'7$.

1187. This appears to contain two condensations, of mags. 13 and 13.5 , the southern one being the brighter.

Possibly the fainter is just outside the nebula.

1188. The position is $2^h\ 59^m\ 3^s$, $-15^\circ\ 52'5$.

1189. The position is $2^h\ 58^m\ 44^s$, $-16^\circ\ 0'8$.

1190. The position is $2^h\ 58^m\ 46^s$, $-16^\circ\ 3'0$.

1191. The position is $2^h\ 58^m\ 50^s$, $-16^\circ\ 4'5$.

1201. This, being pretty bright and pretty small, is good for parallax observations. A star of mag. 10 precedes 5.5^s , $2'6$ north.

1203. Leavenworth says "neb?" It is extremely faint and very small, and lies nearly midway between two stars of mags. 8.5 and 9 . The brighter star precedes 10^s , $1'1$ south.

1204. The discoverer says in the original announcement in No. 146 of the *Astronomical Journal*, "B $\star$ and sev Fst inv in neb." I noticed simply a small triangle of stars of mags. 11, 12, and 13. The brightest star seemed to be enveloped in an extremely faint mantle of nebulous matter. The position of this star is $2^h\ 59^m\ 54^s$, $-12^\circ\ 44'1$.

1228. The position is $3^h\ 3^m\ 45^s$, $-23^\circ\ 18'4$.

1229. This has nearly the same right ascension as 1228, but precedes it a little, contrary to the description "f of 2," in the N.G.C. The position is $3^h\ 3^m\ 45^s$, $-23^\circ\ 20'6$.

1230. The N.G.C. says "? F $\star$." The object is almost a star of mag. 12.5 , but there is some extremely faint nebulous matter about it. The position is $3^h\ 3^m\ 50^s$, $-23^\circ\ 22'1$.

1262. The position is $3^h\ 10^m\ 55^s$, $-16^\circ\ 14'9$.

1263. The position is $3^h\ 11^m\ 0^s$, $-15^\circ\ 28'1$.

1289. The "4 st f" are of about mag. 10, and are not close together, the farthest being perhaps $10'$ from the nebula. The nearest follows the nebula 13^s , $1'8$ south. The position of the nebula is $3^h\ 13^m\ 46^s$, $-2^\circ\ 20'2$.

1290. The position is $3^h\ 14^m\ 43^s$, $-14^\circ\ 21'1$.

1295. Of this Stone says " $\star 10\ f\ 3$." The star follows 13^s , $0'5$ north. The position of the nebula is $3^h\ 15^m\ 22^s$, $-14^\circ\ 21'5$.

1296. The position is $3^h\ 14^m\ 6^s$, $-13^\circ\ 25'6$.

1325. There is a nuclear condensation of mag. 13.5 . The " $\star 9.5\ att$ " follows this condensation 3^s , $0'3$ north.

1359. This was observed in moonlight, but seemed to have a nucleus of mag. 13.

1368. The position is $3^h\ 30^m\ 22^s$, $-15^\circ\ 59'4$.

1371. The centre of this "p B" nebula is of mag. 11.

- 1391 and 1394. On p. 214 of the N.G.C. is the following note

- about these nebulæ. "Nos. 373-74 of Prof. O. Stone's list, *Astronomical Journal*, No. 152, with these notes added: '1st of 3, one of which is G.C. 742,' and '3rd of 3.'" The facts are that G.C. 742 is the first of the three, 1391 the second, and 1394 the third. Micrometrical measures of the three are to be found on pp. 190-1 of Part 6 of Vol. I. of the Publications of the Leander McCormick Observatory. According to these measures the position of 1391 for 1860.0 is $3^{\text{h}} 32^{\text{m}} 34^{\text{s}}$, $108^{\circ} 48' 8''$. On p. 225 of the *Index Catalogue* the N.P.D. of 1391 (derived from the measures mentioned above) is incorrectly given as $108^{\circ} 45' 0''$. My measures of both nebulæ agree with those obtained at the McCormick Observatory.
1405. I did not notice the "F st inv" which are mentioned by the discoverer. The position is $3^{\text{h}} 35^{\text{m}} 43^{\text{s}}$, $-15^{\circ} 51' 3''$.
1414. The position is $3^{\text{h}} 37^{\text{m}} 8^{\text{s}}$, $-22^{\circ} 0' 0''$.
1450. The position is $3^{\text{h}} 40^{\text{m}} 48^{\text{s}}$, $-9^{\circ} 32' 8''$.
1452. The position is $3^{\text{h}} 40^{\text{m}} 53^{\text{s}}$, $-18^{\circ} 56' 7''$.
1509. The position is $3^{\text{h}} 59^{\text{m}} 11^{\text{s}}$, $-11^{\circ} 27' 2''$.
1568. The discoverer says, "nearly bet. 2 st." They are of mag. 10. The nearer one follows the nebula 3^{s} , $0' 6''$ north.
- 1575 and 1577. These are identical, Swift's position for 1577 being nearly correct. The " $\star$ nr s" of 1577, and the " $\star$ 9.5 s 2'" of 1575 are the same. This star follows the nebula 1^{s} , $2' 1''$ south. The central part of the nebula is of mag. 13.
1583. The position is $4^{\text{h}} 23^{\text{m}} 52^{\text{s}}$, $-17^{\circ} 49' 0''$.
1584. The position is $4^{\text{h}} 23^{\text{m}} 41^{\text{s}}$, $-17^{\circ} 44' 6''$.
1594. The position is $4^{\text{h}} 25^{\text{m}} 57^{\text{s}}$, $-6^{\circ} 0' 9''$.
1631. No description of this was given by h; I found it to be very faint and small.
1686. The position is $4^{\text{h}} 48^{\text{m}} 23^{\text{s}}$, $-15^{\circ} 30' 6''$.
1780. The position is $5^{\text{h}} 2^{\text{m}} 0^{\text{s}}$, $-19^{\circ} 36' 1''$.
1886. Instead of a " $\star$ 8 s p 40'" I find that a star of mag. 9 precedes 11^{s} , $0' 9''$ south. A star of mag. 8.5 is about twice as far away, nearly due south.
1889. This is given in the N.G.C. as a "Ld R" nebula, and is said to be a close double with 1888. I examined the locality on one night, when the seeing was excellent, and found a faint star close following 1888; I could, however, see no evidence of its nebular character. I suspected something excessively faint about 10^{s} following the nebula, but thought that "Ld R" would scarcely describe it as a close double with 1888.
1906. * The position is $5^{\text{h}} 20^{\text{m}} 18^{\text{s}}$, $-16^{\circ} 2' 0''$.
1964. This appeared to contain one star of mag. 11, and three of mag. 12. The seeing was not good at the time of observation. H called the nebula " ν S," but it is large.
2054. This was discovered by G. P. Bond, its description in

the N.G.C. being "vF, pS, iR, r? * 9—10 7'n." It appears to be simply a small triangle composed of two stars of mag. 12, and one of mag. 13. They are 7' south of a star of mag. 9. No trace of nebulosity was visible, though the seeing was fine.

2280. The centre of this nebula is equal in brightness to a star of mag. 13.
2352. I saw nothing noteworthy in the place given for this cluster, except that the whole background of the sky in the vicinity contains myriads of minute stars, on the limit of vision.
- 2359 and 2361. In *Monthly Notices*, lviii., 9, on p. 518, there is a note to the effect that 2361 is a condensation in 2359. I have studied these objects on three more nights. 2359 is 6'5 long, north and south, and its average breadth is 3'. It is much narrower in the centre than at the ends, the west side containing a deep notch. 2361 seems, as previously, to be simply the brightest part of 2359. It is possible that Bigourdan, when observing 2361, did not see the large extent of very faint nebulosity surrounding it, and constituting 2359. The N.G.C. right ascension of 2359 is a minute too small; if this error was also in Herschel's *General Catalogue*, Bigourdan may naturally have concluded that his nebula, 2361, was not identical with H's nebula, 2359. The northern edge of 2359 is bounded by a straight row of four stars of mag. 11. The southern half of the nebula is brighter than the northern.
2362. This cluster is 5' in diameter, and consists of stars from mag. 10 down, surrounding 30 Can. Maj. The large star is in the centre.
2367. The stars in this cluster are few and scattered, being from mag. 10 down. There is one double of mags. 10—10, angle 95°, and distance 4".
2374. The diameter of the cluster is 15'; the stars are irregularly scattered, and not particularly numerous; none are brighter than mag. 10.
2382. In *Monthly Notices*, lviii. 9, p. 518, an unsuccessful search for 2382 is noted. The trouble seems to have been that the N.G.C. declination is about 10' out, and the right ascension 18^s in error. The position is 7^h 19^m 52^s, —27° 20'0.
2479. The stars are scattered, and form curves and straight lines, no one being brighter than mag. 10.5. The diameter of the group is about 10'.
2482. The diameter of the cluster is 20'. There is one star of mag. 9 in the preceding part of the cluster; none of the rest are brighter than mag. 10.5.
2483. In this the stars are from mag. 10 down.
2509. In this beautiful little cluster the stars are quite faint; there is one spot in it where the stars are closely

- crowded, giving a nebulous gleam. The average diameter of the entire cluster is $5'$.
2527. The diameter is $20'$. The cluster contains a curious configuration like the Sickle in *Leo*.
2539. The diameter is $15'$, and the brightest stars are of mag. 10.
2542. The discoverer, h, calls this a nebulous star of the fifth magnitude. I examined it on one night, and saw a faint halo about $2'$ in diameter encircling it. It looked like a telescopic glare.
2571. The two brightest stars are of mag. 8.5 . The mean diameter is $15'$.
2580. The average diameter is $6'$.
2587. This contains but one star of mag. 9. Most of the others are fainter than mag. 11.
2589. This I have searched for on three nights without success, though it is supposed to be only "p F."
2590. The star mentioned by Stephan is of mag. 13. The elongation of the nebula is at 80° .
2627. This measures $3'$ north and south, and $6'$ transversely. There are a few stars of mag. 11; the rest are very faint. A smaller cluster of the same general characteristics lies $5'$ south.
2848. The " $\star$ 11 nf $3'$ " is of mag. 9.5 , and follows 10 seconds, $1'5$ north.
- 2863 and 2869. H discovered 2863 and Müller found 2869. Their descriptions agree, but Müller's place for 2869 is erroneous. The two are identical. The two stars mentioned by each observer are of mags. 11.5 and 13 respectively; the brighter lies nearly north, and a rough sketch makes it less than $1'$ distant; the other is twice as far away to the south. 2863 follows 2868 9 seconds, $0'3$ south.
2868. The position is $9^h 18^m 35^s, -10^\circ 0'0$.
2890. The position is $9^h 21^m 44^s, -14^\circ 5'8$.
2983. A star of mag. 14 precedes 2 seconds, a trifle north.
2996. I cannot see any nebula in the N.G.C. place, though the description of h is only "v F." But 33 seconds following it, at nearly the same declination, is a nebula corresponding to h's description, except in one particular. The N.G.C. states " $\star$ 20 f $1'$," while I find a star of mag. 9 which follows the nebula 4 seconds, $0'3$ north. The centre of the nebula is of mag. 13. Its position is $9^h 41^m 52^s, -21^\circ 6'6$.
3085. This is called "R" by h, but it seems to be much elongated at 90° .
3103. According to the N.G.C. this nebula lies between 3100 and 3108, at nearly the same declination. I find no nebula there; by a study of Swift's original record, a

copy of which he kindly sent, it becomes practically certain that he saw 3100, but did not take its place with sufficient accuracy. Therefore 3103 does not exist.

3208. This extremely faint nebula is $1'$ in diameter, and lies half way between two stars of mag. 10.5 on nearly the same parallel. A rough sketch makes it $2'$ distant from each star. Its position is $10^h 15^m 2^s, -25^\circ 18'9''$.
3233. The position is $10^h 17^m 12^s, -21^\circ 45'8''$.
3313. This is a nebulous star of mag. 12. The " $\star 15 n 3''$ " is really south of the nebula. The position of the nebula is $10^h 32^m 41^s, -24^\circ 47'8''$.
3331. The position is $10^h 35^m 22^s, -23^\circ 17'9''$.
3369. The position is $10^h 41^m 58^s, -24^\circ 43'0''$.
3420. The position is $10^h 45^m 15^s, -16^\circ 42'7''$.
3464. This has an excentric faint nucleus and is much elongated at 135° . Its position is $10^h 49^m 48^s, -20^\circ 32'0''$.
3479. The position is $10^h 53^m 57^s, -14^\circ 25'5''$.
3508. Of this the N.G.C. remarks, " $\star nf inv.$ " I see only a star of mag. 12, $30''$ or $40''$ distant at 20° . H noted the nebula as "S," with which my estimate of its size agrees; h called it " $v L$," and probably thought that the star just mentioned lay within the outlying nebulosity.
3717. This " $m E$ " object is remarkable in that it looks like a comet with a bright head.
3727. The " $\star 11 sf 1'$ " is of mag. 12, and follows 5 seconds, $0'7''$ south. The position of the nebula is $11^h 28^m 38^s, -13^\circ 19'5''$.
4024. The position is $11^h 53^m 25^s, -17^\circ 47'3''$.
4188. The position is $12^h 8^m 59^s, -12^\circ 1'7''$.
4201. The position is $12^h 9^m 33^s, -11^\circ 1'6''$.
4680. The discoverer said " 1 or 2 st inv." I did not see any, but a star of mag. 11 follows the nebula 1 second, $0'1''$ south.
4700. The " $B \star p$ " is of mag. 10 and precedes 9 seconds, $0'1''$ north. The nebula is nearly $2'$ in length and very narrow. At times there seemed to be 3 or 4 minute condensations.
4802. This was searched for in vain on one night. Its description is so similar to that of 4804 that they may be identical, if the declination of 4802 is just 1° in error.
4862. Another was suspected perhaps $5'$ south of this one. The position of 4862 is $12^h 54^m 15^s, -13^\circ 35'5''$.
5051. The position is $13^h 10^m 50^s, -27^\circ 45'4''$.
5072. This nebula of d'Arrest's I observed in moonlight, when it looked almost like a double star of mags. 12-13, angle 30° , and distance $15''$. The " $\star 14 nf$ " is of mag. 11.5, and follows 7 seconds, $0'7''$ north.
5097. This appears to be elongated at 45° . The discoverer

- says "nearly bet. 2 st." The stars are of mags. 9.5 and 11. The brighter of them follows the nebula 9 seconds, 0'.8 north. The fainter is about twice as far away.
5291. The " $\star$ p" is of mags. 9.5 and 10, and wide, with an angle of 200° . The brighter star precedes the nebula 9 seconds, 0'.9 north.
5304. The " $\vee$ F $\star$ f" is at 160° , 0'.7 distant, and is of mag. 12. The position of the nebula is $13^h 44^m 19^s$, $-30^\circ 4'.9$.
5425. The nebula is much elongated at 290° . The position is $13^h 56^m 57^s$, $+48^\circ 55'.6$.
5439. The elongation is at 0° . The position is $13^h 58^m 1^s$, $+46^\circ 47'.7$.
5459. The "p B $\star$ sp" is of mag. 10.5, and precedes 6 seconds, 1'.4 south.
5495. The " $\star$ sf" is of mag. 10, and follows 2 seconds, 0'.4 north.
5597. There is a good nucleus of mag. 12.5.
5624. The position is $14^h 23^m 9^s$, $+52^\circ 2'.1$.
5664. Two or three other very faint nebulae are suspected near by. The position of 5664 is $14^h 28^m 15^s$, $-14^\circ 10'.8$.
5707. The N.G.C. description is "B, pS, R." This is correct for the central portion of the nebula. But there appear to be two extremely faint and opposite extensions, which bring to mind certain drawings of the solar corona.
- 5734 and 5743. The discoverer puts these a minute apart in right ascension, and gives them the same declination. I find two nebulae at nearly the same right ascension, which differ 2'.6 in declination, and see nothing else in the neighbourhood; 5743 is much elongated at 90° . I make 5734 brighter than 5743, while the discoverer has it fainter. It is possible that Leavenworth did not notice the nebular character of one of the objects which I saw (as it is very small, and has a stellar nucleus of mag. 13), and either saw something which I missed, or saw 5743 on two different nights, recording it as two objects because of the differing positions obtained for it. Yet it seems preferable to assume that we observed the same objects, and that the preceding one of the two should be called 5734. Possibly a larger telescope will be needed for a definite decision. The positions are:—

			^h	^m	^s		[°]	[']	⁹
5734	...	...	14	39	29	—	20	26	9.
5743	...	...	14	39	31	—	20	29	5.

5762. The position is $14^h 43^m 55^s$, $+12^\circ 52'.4$.
5763. The position is $14^h 44^m 11^s$, $+12^\circ 54'.4$.
5766. The position is $14^h 47^m 26^s$, $-20^\circ 58'.3$.

5781. The " $\star 16sp$ " I did not see. But there are two stars of mag. 12 close by the nebula, south, preceding and following respectively.
5793. The elongation is at 160° . The position is $14^h 53^m 50^s$, $-16^\circ 17'.6$.
5801. The position is $14^h 54^m 56^s$, $-13^\circ 30'.5$.
5802. The position is $14^h 55^m 0^s$, $-13^\circ 31'.4$.
5803. The position is $14^h 55^m 4^s$, $-13^\circ 29'.9$.
5810. The nebula lies "*bet. 2 v F st*" which are of mag. 13.5 and are distant from the nebula about $0'.7$, nearly north and south respectively. The position of the nebula is $14^h 57^m 5^s$, $-17^\circ 28'.5$.
5815. I could not find any nebula in the N.G.C. place for this, but 100 seconds preceding was a nebula which answered the description of 5815, except that I saw no "*D $\star$ inv.*" But the seeing was not very good. The position is $14^h 54^m 54^s$, $-16^\circ 26'.1$.
5817. The position is $14^h 54^m 7^s$, $-15^\circ 46'.9$.
5855. The "*2 st n f*" are of mags. 10.5 and 13. The brighter follows the nebula 3 seconds, $1'.3$ north.
5878. The centre is of mag. 12.
5978. The position is $15^h 36^m 54^s$, $-12^\circ 54'.8$.
6080. This is accompanied by a star of mag. 12.5, $20''$ distant at 45° , which appeared to be nebulous.
6168. The "*F $\star$ at p end*" I did not see. The position of the nebula is $16^h 25^m 32^s + 20^\circ 27'.1$.
6225. The N.G.C. says "*F st inv.*" These I did not see, but there is a star of mag. 13 which follows 1 second, a little south.
6335. This is described by L as "*Dif. neb. in patches.*" On one good night this was carefully sought, both with the twenty-inch, and with its five-inch finder. Nothing was discerned except possibly a very diffuse and extremely large nebulous region.
6356. In the N.G.C. this is described as a globular cluster of stars, "*vB, c L, vgvmbM, r r r, st 20.*" It was very carefully examined on one night when the seeing was fine, but no stellar character could be made out. The longer one looked the more probable it seemed that the object was a nebula. The brilliant part of it is $30''$ in diameter, the brightest spot being a little south of the centre of this brilliant portion. A number of 14 mag. stars were close to the nebula, south preceding.
6360. For this h notes "*Neb in patches (Milky Way).*" On one good night nothing definite was discernible here. However, the general background of the sky in this region was noted as being not so dark as would be expected if no nebulous matter were present.
6450. On each of three nights I hunted unsuccessfully for this; from its description it should not be difficult.

6562. The position is $18^h 3^m 13^s, + 56^\circ 15'2$.
6582. A star of mag. 13.5 precedes about 2 seconds. The position of the nebula is $18^h 8^m 37^s, + 49^\circ 53'0$.
6585. The elongation is at 45° , the nebula being $1'0$ or more in length, and brighter in the middle. It appeared to have a backbone or central stripe of greater brightness than the rest. The position is $18^h 9^m 5^s, + 39^\circ 36'3$.
6592. The position is $18^h 8^m 48^s, + 61^\circ 23'9$.
6597. The "B * nr" is of mag. 8.5, and precedes the nebula 25 seconds, $0'3$ north.
6601. The position is $18^h 10^m 43^s, + 61^\circ 25'6$.
6607. On three nights this was looked for without success. On one of the nights, which was fine, I suspected one or two objects in the immediate vicinity, but could not be certain. As it is "v. diffic." a larger telescope might well be tried on it.
- 6608 and 6609. A nebula supposed to be 6609 was measured in two nights. Its position differs from that given by Swift only 16 seconds in right ascension, and $0'4$ in declination. The "F * nr" is of mag. 12, and lies about $25''$ south of the nebula, a little preceding. There is another star of mag. 13.5 which is on the opposite side of the nebula, at about the same distance. 6608 is supposed to precede 6609 by 5 seconds at the same declination, but I could not find it on any one of three nights, one of which was very fine. I presume that it is identical with 6609. The position is $18^h 11^m 30^s, + 61^\circ 18'2$.
6612. I was unable to find anything in the N.G.C. position for this "v. diffic." object, but I measured a supposed nebula about $5'$ away, making at the time of observation the following note "e F, e S ; a little question whether there really is nebulosity here." Possibly 6612 is identical with (1279), with an error of 5 minutes in right ascension. The position of the measured nebula is $18^h 12^m 41^s, + 36^\circ 2'5$.
6617. The position is $18^h 13^m 2^s, + 61^\circ 17'0$.
- 6621 and 6622. In the N.G.C. these have the same right ascension. One precedes the other several seconds. I retain the number 6622 for the northern one of the two ; it appears to be a star of mag. 12.5, with a faint formless surrounding nebulosity. 6621 seems to be a star of mag. 13, with a shred of nebulous matter clinging to it. The positions are :
- | | | | | |
|------|-----|-----|---|---------------|
| | | | $\begin{smallmatrix} h & m & s \end{smallmatrix}$ | |
| 6622 | ... | ... | $18\ 13\ 24,$ | $+ 68\ 19'9.$ |
| 6621 | ... | ... | $18\ 13\ 28,$ | $+ 68\ 19'3.$ |
6636. The three stars mentioned by Swift are of mags. 9, 9.5, and 10.5. The one of mag. 9.5 follows the nebula 4 seconds, $1'0$ south. The others precede, and are also south.

6645. This is composed of scattered faint stars, is about 10' in diameter, and has in its centre a nearly circular "hole," 2' in diameter, in which only a few tiny stars are visible.
6646. In hunting for (1288) I came across this nebula, and noted that it contained a good condensation of mag. 13.
6647. Here is simply a region where small stars are a little more crowded than commonly. It seems hardly sufficiently condensed to be called a cluster.
6649. This is a widely scattered cluster about 5' in diameter. The brightest star is of mag. 9, and is at the southern end of the cluster; it has a companion of mag. 11 at 90° , 5'' distant.
6651. The position is $18^h 25^m 52^s$, $+71^\circ 32'4$.
6666. An unsuccessful search for this was prosecuted on two nights. As it is called "v. diffic.," the region may well be examined with a larger telescope. Swift writes that this was discovered by his son, and that its position may not be very exact.
6667. The double-star mentioned by Swift is of mags. 11—11, and distance 40''; it follows the nebula several seconds. The elongation is at $90^\circ \pm$. The position of the nebula is $18^h 31^m 0^s$, $+67^\circ 54'7$.
6668. This is called "pB, pS, mE" by its discoverer, and therefore ought to be an easy object. I have searched for it on three nights unsuccessfully, and conclude that no such nebula exists in or near the place given for it. It may be identical with 6677, which follows about 3^m at nearly the same declination.
6676. The position is $18^h 33^m 15^s$, $+66^\circ 52'7$.
6677. The N.G.C. says: "bet. *v close and vFD*." I did not notice the very faint double star; the other one is of mag. 12, and follows the nebula 2^s , 10'' south. The position of the nebula is $18^h 33^m 42^s$, $+67^\circ 1'7$.
6678. Though this is only "pF, pS," I was unable to find it on either one of two nights. Its presumably fainter neighbours 6677 and 6679 were measured.
6679. This is a nebulous double star of mags. 12.5, distance 5'', and angle 60° . The N.G.C. place is $8'5$ out in declination. The position is $18^h 33^m 37^s$, $+67^\circ 3'3$.
6687. The position is $18^h 36^m 1^s$, $+59^\circ 33'2$.
6690. This is given as "R" in the N.G.C. But it really has two faint wings stretching out north and south from the much brighter centre, making the nebula $1'5$ long. At its northern end is a star of mag. 12.
6691. For this the N.G.C. gives the note "pB*Snr," which is evidently intended for "pB*snr." The star is of mag. 9.5, and is $3'0$ distant.
6696. The N.G.C. place is 1^m out in right ascension and 2' in declination. The nebula is elongated north and south,

- and is a difficult object. The position is $18^h 38^m 39^s$, $+59^\circ 14' 3''$.
6701. The elongation is very pronounced, and is at 120° , the nebula pointing at a star of mag. 10, less than $1'$ distant. There is one condensation of mag. 13; one of mag. 14 was suspected at the preceding end of the nebula.
6714. On three nights this was looked for unsuccessfully. Upon each of them there was noticed a group of four stars of mag. 14, about 1^m following the N.G.C. place of 6714, and near "sev B st," as noted by the discoverer. On one night of the three an extremely faint nebula was suspected close to the N.G.C. place of 6714. A larger telescope or keener eye may be needed to clear this matter up.
6732. This is star-like, and of mag. 12.5. The "F*nr" is of mag. 11, and precedes 1^s , $0' 6''$ north. The position of the nebula is $18^h 54^m 5^s$, $+52^\circ 14' 7''$.
6747. On two nights this was searched for in vain. Swift says "p B st sf." I saw a star of mag. 8.5 in the vicinity, and only very faint stars in the location of the nebula. As Swift calls it "ee F v. diffic.," a larger telescope may well examine the region.
6757. Swift says "3 F st inv." I was unable to verify this, but saw two stars of mag. 12 close south preceding. The position is $19^h 3^m 7^s$, $+55^\circ 33' 8''$.
6759. The "v FD* close sp" noted by Swift, is of mags. 11.5—12.5, and distance $15''$. I think that there are involved in the nebula three stars of mags. 13.5, 14, and 14.
- 6762 and 6763. These are identical; Swift admits it. The region was scrutinised on one night, the definition being fine. A star of mag. 13 follows the nebula 1^s , a few seconds of arc south. It is doubtless the star referred to in the description of 6763, and does not appear to be nebulous. The position is $19^h 4^m 51^s$, $+63^\circ 46' 7''$.
6764. The elongation is north and south. Four stars of mag. 13.5 are involved, one near each end, and the others in the middle.
6786. The "2 st n f" are of mag. 10. The nearer one follows 11^s , $1' 0''$ north. The more distant is very nearly north of the nebula, at a distance of about $2'$. The N.G.C. description is "e e F," but the nebula appears to be only "F."
6787. The "4 st s f" are of mag. 10.5, form a rude square, and are judged by a rough sketch to be $5'$ distant from the nebula. The position is $19^h 14^m 45^s$, $+60^\circ 14' 3''$.
6796. This is very much elongated at 0° , and certainly contains one bright spot of mag. 13.5; perhaps there are others. There is a resemblance to the great nebula in *Andromeda*. The position is $19^h 20^m 10^s$, $+60^\circ 57' 3''$.
6801. This contains at least one stellar point of mag. 13.5.

- The "F * snr" is of mag. 11.5, and precedes the nebula 3^s, 1'3 south.
6817. The position is 19^h 36^m 8^s, +62° 9'4.
6825. The "F * nr" is of mag. 10, and precedes the nebula 3^s, 0'5 north. Two stars of mags. 8.5 and 9 are about 5' south following. The position is 19^h 40^m 54^s, +63° 50'1.
6829. The "p B * " mentioned by Swift is of mag. 9, is 0'7 south of the nebula, and follows 2^s. The position is 19^h 45^m 25^s, +59° 39'5.
6831. The position is 19^h 46^m 15^s, +59° 38'5.
6869. The position is 19^h 59^m 56^s, +65° 56'9.
6907. By my sketch this is much elongated at 90°. The centre is as bright as a star of mag. 13. The "3 st p," mentioned in the N.G.C., do not appear in my sketch, and are therefore probably more than 5' away.
6916. The "F * close p" is of mag. 12, and the position of the nebula is 20^h 21^m 21^s, +58° 1'3.
- 6927, 6928, 6930, (1325) and (1326). On page 137 of my communication in *Monthly Notices*, vol. lx., No. 2, the opinion was expressed that (1325) and (1326) were identical with 6928 and 6930 respectively. But the fact that I had not noticed the much fainter object 6927, which was in the same field of view, threw some doubt upon my conclusions. But on the evening of 1899 October 6, I measured the positions of objects which are in the places given in the N.G.C. for 6927, 6928, and 6930. The seeing was good, the stars being bright and quiet. (1326) must be identical with 6930, because their positions and descriptions, as given by Swift and Marth respectively, agree well enough with each other and with my description of the same object. The elongation noted by all of us is at 180°. The "p F * s" mentioned by Swift is of mag. 10, is 0'9 south of the nebula, and precedes it 1'4^s. 6928 is the brightest of the three, and my position of it agrees with Marth's. Swift's position for (1325) agrees exactly in right ascension with Marth's for 6928, but differs 3'0 in declination. I am confident that no nebula answering to the description of (1325) exists in the N.G.C. place of that object. 6927 is extremely faint and extremely small, looking like a star of mag. 13, with but a trace of outstanding nebulosity. South and a little preceding 6927 is a row of four small stars, 1'5 long, pointing at the nebula; the nearest star is only 2' from it. Possibly this line of stars is a trifle nebulous. The positions are:—

			h	m	s	°	'
6927	...	...	20	27	49,	+9	34'6
6928	...	...	20	28	1,	+9	35'2
6930	...	...	20	28	10,	+9	32'0

6931. Though this is very small, it is much elongated at 120° . At times it appeared to have a condensation near each extremity, but the seeing was not very good. The position is $20^h 28^m 13^s$, $-11^\circ 42' 5''$.
6951. The position is $20^h 35^m 59^s$, $+65^\circ 45' 2''$.
6953. I could not find this, which is called by Swift "eeF, p L, v. diffic." 17^s preceding and $0' 2''$ south of the place given by Swift is a small group of at least four stars of mag. 14, which was scrutinised for nebulosity, but in vain. The position of the preceding one of the stars was taken, and is $20^h 36^m 23^s$, $+65^\circ 24' 7''$.
6981. This is a bright and easily resolvable globular cluster. But the most brilliant portion is not at the centre, but near the preceding edge.
7015. This contains a condensation of mag. 13.5.
7136. A note about this appears on p. 359 of the *Monthly Notices*, vol. lviil., No. 6. The nebula has been observed again, with the same result concerning its appearance. In the N.G.C. we read " $*9.5 f 2'$." The magnitude of the star is really about 10.5.
7302. This is suitable for parallax measures, having a good condensation. A star of mag. 8.5 is about $3'$ distant.
7306. The " $*11 p$ " appears to be of mag. 10, and precedes 8^s , $0' 7''$ north. The nebula seems brighter near its preceding end.
7308. This nebula would be good for parallax observations with a large telescope. Its position is $22^h 29^m 13^s$, $-13^\circ 27' 0''$.
7437. The " $F * nr n f$ " is of mag. 10.5, and follows 4^s , $1' 4''$ north. The position of the nebula is $22^h 53^m 12^s$, $+13^\circ 46' 3''$.
7455. Swift says " $F * close p$." I found none there, but a star of mag. 10 follows 5.5^s , $1' 2''$ north.
7495. The " $*9 n f nr$ " is of mag. 10.5, and follows less than 1^s , $1' 3''$ north. There is a star of mag. 9 about $5'$ south following.
7511. There is a star of mag. 13.5 about $30''$ south of the nebula. The discoverer says " $sev st n f$." I see a row $15'$ in length, composed of six stars of average mag. 10, which runs at a position angle of 135° ; its centre lies about $3'$ north following the nebula.
7522. A search on three nights failed to reveal this.
7573. The N.G.C. right ascension is about 50^s too large. Accurate measures were prevented by the coming up of haze.
7627. I failed to find this on two nights. In reply to a letter of inquiry, Swift says that this is identical with 7641, one of Stephan's nebulæ which I have measured. With this opinion I agree, having seen near 7641 the " $2 st n$ " mentioned by Swift.

7720. There seems to be a small nest of nebulae clustered about this one. I have measured two, and suspected some others. An examination with a large telescope might be fruitful. 7720 is described as "1 E, b M." It looks like a nebulous double star of mags. 12-13.5, angle 10° , and distance 10".
7754. The N.G.C. right ascension is a minute and a half too small. The position is $23^h 44^m 2^s$, $-17^\circ 9' 3''$.
7759. The "B*n" is of mag. 8.5, and precedes the nebula a fraction of a second, $2' 7''$ north. The nebula has a good nuclear brightening, and would readily lend itself to parallax observations. The position is $23^h 43^m 45^s$, $-17^\circ 5' 8''$.
7763. The "F*f" is of mag. 13.5, and follows about 2^s , a trifle north. The position of the nebula is $23^h 45^m 7^s$, $-17^\circ 8' 7''$.
7774. The N.G.C. says "in centre of 3 st." Each side of the triangle is about 4' long, and the stars are of mags. 10, 11, and 12.
7808. The "stell. N" is of mag. 13. The " $* 8.5$ sp 3'" precedes 13^s , $1' 6''$ south. The position is $23^h 58^m 25^s$, $-11^\circ 18' 1''$.
7813. I do not find anything in the N.G.C. place of this Müller nebula. But 55^s following, at nearly the same declination, I found a similar object, elongated, however, at 160° , while Müller puts the elongation at 80° . He says " $* 8.5$ f 38^s ," while I found such a star preceding 49^s . He also says " $* 9$ np 40^s ." There are two such stars about 8' north, and a few seconds preceding. The region may well be examined with a larger telescope. The position is $23^h 59^m 2^s$, $-12^\circ 32' 4''$.

Nebulae from the Index Catalogue.

- (81). I could find no " $*close$ n f." A star of mag. 11 follows 3^s , $0' 3''$ south. The position of the nebula is $1^h 4^m 16^s$, $-2^\circ 13' 8''$.
- (179). The " $* 9.5$ n f" follows 10^s , $1' 4''$ north. The position of the nebula is $1^h 54^m 13^s$, $+37^\circ 32' 2''$.
- (395). The "F*close f" is of mag. 12, and follows $1' 5^s$. The position of the nebula is $4^h 44^m 26^s$, $+0^\circ 4' 7''$.
- (438) and Swift 88. These are identical, despite their differing descriptions. Swift, writing under date of 1900 January 27, says that "they are no doubt the same." The "v wide D* nr p" is of mags. 9-9.5, distance 45'', and angle 170° . The brighter of the two stars precedes the nebula 15^s , $0' 7''$ north. I have discovered another fainter nebula, which precedes 24^s , $5' 4''$ north.
- (453). On the fine night on which I measured (452) I looked for this one in vain. In its place I could see only two or

- three stars of mags. 13-14. Bigourdan, the discoverer, says "★ 13 in S neb, or 2 or 3 st close."
- (468). I hunted for this on two fine nights unsuccessfully. There are hosts of stars in the vicinity. The place is near that of the large nebula 2359.
- (507). A search for this on three nights has failed.
- (760). Either there is a star of mag. 14 at 150° , or the nebula is elongated in that direction.
- (784). The "p B★s" is of mag. 8.5, and precedes $0^h 6^m 2^s 9$ south. The N.G.C. declination is several minutes of arc out. The elongation of the nebula is at 90° , and its position is $12^h 17^m 22^s$, $-4^\circ 5' 9$.
- (847). The description "bet. 2 st" given in the *Index Catalogue*, I cannot verify from my sketch of the field of view.
- (852). Corresponding to the description "B★p" I find one of mag. 9, which precedes about $3'$, by a rough sketch, and is a little north. The position of the nebula is $13^h 3^m 37^s$, $+60^\circ 41' 5$.
- (997), (998), Swift 168, and Swift 169. I have examined this locality with considerable care, and see three nebulae, one of which is evidently a *Nova*, as its description is widely different from that of any of the others. (997) and Swift 168 agree in description, and are thought to be identical. The "★ with dist. comp. nr n" is of mag. 9.5, and follows the nebula less than 1^s , $1' 3$ north. Its companion is of mag. 10.5, and is $40''$ distant from the brighter star, at an angle of 225° . (998) is very much fainter and smaller than (997), and is judged to be identical with Swift 169. Near it is a star of mag. 14, at an angle of 180° and distance of $20''$. Perhaps it is involved in the faint outlying nebulosity. It is to be noticed that, according to the *Index Catalogue* (998) follows (997) 18^s , $1' 0$ north, these differences of co-ordinates being identical with those obtained from A.N. 3517, for Swift 168 and 169. The positions of the three nebulae are :—

			h	m	s	°	'
<i>Nova</i>	...	...	14	14	12,	-4	1'6
(997)	...	...	14	14	47,	-3	59'5
(998)	...	...	14	15	7,	-3	57'4

- (1027). Swift suspected "another nr." I saw no nebula near by, but there was a star of mag. 13, which was $0' 7$ south preceding.
- (1031). The position is $14^h 30^m 50^s$, $+48^\circ 28' 5$.
- (1071). The position is $14^h 49^m 13^s$, $+5^\circ 9' 5$.
- (1101). The *Index Catalogue* gives no description of this. I find it to be extremely faint and very small. A star of mag. 13 follows $1' 5^s$, at nearly the same declination, and another precedes 2^s , a little north.

(1121). The "v F * close p" is of mag. 13.5, and is 20" distant at 315° .

(1149) and Swift 182. These are identical. The "trapezium," mentioned by the discoverer, is nearly a rhomboid, whose longer diagonal is about 8' in length, by a rough sketch, and stands at a position angle of 135° ; the shorter diagonal is about 4' long. The stars are of mags. 9.5, 10.5, 10.5, and 11.5, the brightest being in the southern end of the long diagonal. The position of the nebula is $15^{\text{h}} 53^{\text{m}} 26^{\text{s}}, +12^{\circ} 21' 4''$.

(1196). Of this the *Index Catalogue* says "nr p * of 3 in line." It is somewhat difficult to determine which stars are referred to. The brightest star near by is of mag. 8.5, and follows the nebula $8^{\text{s}}, 1' 3''$ south.

(1247). On two nights this was hunted for in vain. On the second night, when the seeing was fine, it was noted that there is a star of mag. 13 in the place given, which satisfies the description " * 9.8 sp 0.7," but no trace of nebulosity was discernible about the star.

(1268). The position is $17^{\text{h}} 46^{\text{m}} 13^{\text{s}}, +17^{\circ} 14' 3''$.

(1269). As the position given in the *Index Catalogue* differs from mine 20^{s} and $2'$, and I was unable to verify Swift's description of "p L, 2 F st nr," I examined the locality with care, under excellent atmospheric conditions. But I found only the following "eeF, vS" nebula, which is assumed to be (1269). A number of faint stars lie near, most of them being south of the nebula. Perhaps there are a dozen brighter than mag. 13 within a distance of 5'. The brightest one is of mag. 10, and is (judging by a rough sketch), about 4' south preceding the nebula. No other brighter than mag. 11.5 is shown in the sketch.

The position is $17^{\text{h}} 47^{\text{m}} 52^{\text{s}}, +21^{\circ} 35' 6''$.

(1279) and (1281). In the *Index Catalogue* is a query whether these are identical. Their descriptions are not radically divergent. I see only one nebula in the vicinity, and call it "v F, p S." Within 5' north following are four stars of mag. 9; 11^s following and 1' 0" south is a double of mags. 9.5—10, and distance 3".

The position is $18^{\text{h}} 7^{\text{m}} 45^{\text{s}}, +35^{\circ} 59' 0''$.

(1288). The discoverer mentions "3 st nr." They are of mag. 10, and form a triangle within which the nebula lies, near the middle of the south following side. The triangle lies about 5' south of a star of mag. 8.5, and follows it a few seconds.

(1289). The stars referred to in the description "3 st nr" probably are the ones constituting a triangle each side of which is about 5' long, which lies south of the nebula. The vertices nearest the nebula are marked by stars of mag. 10 and 10.5, which have nearly the same declination. The third vertex is marked by a star of mag. 8.5, which is nearly due south of the nebula, distant about 7'.

The position of the nebula is $18^h 26^m 46^s$, $+39^\circ 53' 7''$.

(1291). The discoverer mentions a "F * close n." This I am unable to see. Two stars of mag. 12 lie north following and north preceding, respectively. North following the nebula, at a greater distance lie two of mag. 10, which point at it. They are (by a rough sketch) $1'$ or $2'$ apart. The nearer one precedes the nebula 8^s , $2' 3''$ north.

The position is $18^h 31^m 19^s$, $+49^\circ 11' 8''$.

(1293). Swift describes this as "eeF, S, lE, * in centre, ? D." It appears to consist of three stars of mag. 14, of which the following one is nebulous.

(1300) and (1301). On each of two nights I searched for these in vain. A letter from Swift states that the N.P.D. given for (1300) in the *Index Catalogue* is 1° too great. Making this correction (1300) becomes identical with 6798. In the same letter Swift states that the declination of (1301) is about $+49^\circ 40'$, which is $35'$ greater than the declination (for 1900.0) computed from the *Index Catalogue*.

(1368). This is called "R" by its discoverer. On each of two nights I noted it as much elongated at 225° . On one of the nights it appeared to contain two stellar points, one near each end.

(1420). The position is $21^h 57^m 48^s$, $+19^\circ 16' 1''$.

(1487). The "F * nf" is of mag. 12, and is close to the nebula. There is also a star of mag. 11.5 at about the same distance south preceding. The " * 8 f" must be a long way off, as I saw no such star in the vicinity. There is a star of mag. 7, which precedes about 15 seconds, $9' 2''$ south.

Swift's Recently Discovered Nebulae.

Swift 12, 3. On p. 568 of *Monthly Notices*, vol. lix. No. 10, the discoverer says that a "wide D * close p point to it." The magnitudes of the components of the double are 9.5 and 12, and by a rough sketch I judge their distance apart to be $1'$ or $2'$. The star of mag. 9.5 precedes the nebula 8 seconds, $0' 1''$ north. A star of mag. 13 is close to the nebula, south following.

Swift 10. The " 9^m * nearly in contact np" precedes 0.5 second, $0' 5''$ north, and I rated it as of mag. 10. The position of the nebula is $0^h 56^m 44^s$, $-16^\circ 6' 3''$.

Swift 26. The position is $1^h 46^m 11^s$, $-10^\circ 17' 2''$.

Swift 28. The " 9^m nr np" precedes 7 seconds, $1' 6''$ north. The position of the nebula is $1^h 51^m 8^s$, $+5^\circ 8' 3''$.

Swift 32. Swift says "bet. 2 southern of 4 stars." The stars are of mag. 10.5, and form a large trapezoid, the southern and longest side of which is about $7'$ in length, and stands at a position angle of 60° .

Swift 43. The position is $2^h 37^m 18^s$, $-28^\circ 35' 8''$.

Swift 60. I have not yet observed this, but it may be

identical with one which was observed by Müller in 1887, but which is not found in the *Index Catalogue*, or in the N.G.C. The observation of it is No. 171 on pp. 192-3 of Part 6 of vol. I. of the *Publications of the Leander McCormick Observatory*. Its position for 1900.0 is $3^h 37^m 15^s$, $-18^\circ 35' 2''$, which differs from that of Swift 60 by 14 seconds in right ascension, and $2' 9''$ in declination. It is also noteworthy that if the sign of $\Delta\alpha$ in Müller's observation be changed, the position of his nebula will coincide with that of 1440. The region $3^h 33^m$ to $3^h 43^m$ between the declinations $-18^\circ 30'$ and $-19^\circ 0'$ might well be explored thoroughly with a large telescope, as it contains many nebulae.

Swift 74. Swift's declination for this is nearly $10'$ in error. He says "close to e e e FD *." The double is of mags. $12.5-12.5$, distance $90''$, and angle 210° . The nebula is near the northern one of the two stars. The position of the nebula is $5^h 2^m 32^s$, $-20^\circ 28' 6''$.

Swift 75. The discoverer says " 7^m * 15^s p l s" nearly obliterates it. The star precedes 14 seconds, $3' 6''$ south. The position of the nebula is $5^h 15^m 39^s$, $-25^\circ 10' 0''$.

Swift 85. The elongation is at 90° . The position is $5^h 42^m 30^s$, $-18^\circ 45' 7''$.

Swift 96. Of this Swift says "vF * close nf, pB * near sp." The very faint star is of mag. 12.5 , and is distant $40''$ at 10° . The brighter star is of mag. 9, precedes the nebula 6 seconds, and is $2' 4''$ north instead of south. The position of the nebula is $9^h 40^m 14^s$, $-31^\circ 19' 9''$.

Swift 106. The trapezium mentioned by Swift consists of stars of mag. 9.5 . The position of the nebula is $10^h 11^m 51^s$, $-33^\circ 2' 8''$.

Swift 107. The " 9^m p close f" follows the nebula 9 seconds, $0' 4''$ south. Nearly between the two is a star of mag. 10.5 . There is also a star of mag. 12.5 , which follows $40''$, at 80° . The nebula has a good nucleus of mag. 13. Its position is $10^h 17^m 6^s$, $-33^\circ 45' 8''$.

Swift 108. 3257, 3258, and 3260 are in the same field, and I measured them all on the same night, but could not see Swift 108, which is supposed to be close by. 3260 has a star of mag. 11.5 about $20''$ south, and Swift 108 is said to have an "e F * in contact." Since the position and description of Swift 108 agree closely with those of 3260, I judge them to be identical.

Swift 111. The " 8^m * close p" is of mag. 9, and precedes 4 seconds, $0' 2''$ north. The description "eE" may have arisen from the fact that there is a star of mag. 13 close by, south following.

Swift 115 and 116. Swift says in a letter that these are to be dropped. The former is evidently identical with the

h nebula 3333. The " $\star$ 15 att" is of mag. 13, and directly south of the nebula.

Swift 120. This has a stellar nucleus of mag. 13.5.

Swift 130. There is no nebula in the place given for this, but about 15' away there is one corresponding to the description, and answering the condition " $7^m \star$ sp." Its position is $11^h 50^m 11^s$, $-37^\circ 8'4$.

Swift 131 and 133. These were discovered on different nights; their positions agree closely, and their descriptions fairly. I examined the locality on two nights, and found only one nebula, which is elongated at 120° , is about 1'5 long, and points toward a star of mag. 9, which follows 15 or 20 seconds.

Swift 132. This must be identical with 4087, since both are pretty bright, and their places agree within three seconds in right ascension and 1' in declination. The "triple $\star$ sp" mentioned by Swift is of mags. 10, 12, and 12; the brightest component precedes the nebula 8 seconds, 3'9 north.

Swift 134. The " $D \star sf$ " is of mags. 10-10.5, angle 45° , and distance 40''; it is 8' from the nebula. Just south of the nebula, and pointing at it is a row of five stars of average mag. 11'5, the farthest being less than 10' away. The nebula is considerably brighter than the description "eee F, v diff." would imply.

Swift 135. The " $\star$ close sf" is of mag. 10.5, and follows 2 seconds, 0'6 south. The position of the nebula is $12^h 3^m 51^s$, $-30^\circ 57'7$.

Swift 137. The position is $12^h 19^m 51^s$, $-39^\circ 13'2$.

Swift 139. I see no " $7^m \star nr p$," but found one of mag. 8.5, which precedes 15 seconds, 1'5 south. The position of the nebula is $12^h 22^m 19^s$, $-38^\circ 47'0$.

Swift 140. Instead of "2 or 3 vF st in contact," I noticed only one of mag. 12.5, south and a little preceding. The position of the nebula is $12^h 35^m 30^s$, $-36^\circ 12'4$.

Swift 145. This is larger and much brighter than the description "eee F, eee S" implies. The nearest of the " $3 vF st n$ " is of mag. 10, and precedes 5 seconds, 1'0 north. The " $7^m \star s$ " is 10' distant. The position of the nebula is $12^h 52^m 50^s$, $-22^\circ 20'1$.

Swift 149. The " $11^m \star nr p$ " is of mag. 12, and precedes 11 seconds, 0'3 north.

Swift 150. The position is $13^h 2^m 41^s$, $-23^\circ 15'7$.

Swift 158. There is an error of about 7' in the declination given in *A. N.* 3517, the nebula being north of the position there given.

Swift 159. Of this the discoverer says "like a $D \star$, one nebulous." I cannot perceive this appearance.

Swift 183. I have searched for this in vain on two nights.

As it is called "eee F" perhaps a larger telescope may well look for it.

Swift 197 and 198. The announced positions put these at the same declination, and make them differ only 15 seconds in right ascension. They were discovered on the same night. 197 is called "v F, R," and 198 "ee F, eE." I examined the locality on three nights, and could find only one nebula which is 1' in length, and elongated at 160° ; on one night it was suspected of being binuclear. Swift says of 197 "2 F st near nf point to it," and of 198 "near p * of sev. curved." Both these statements are true of the nebula which I observed. On two of the three nights I also measured Swift 199, which is in the same field of view, was discovered on the same night, and is described by Swift as fainter than 197 and 198. Swift has sent me a copy of his original records, which says of 198 "sp of 2," and of 199 "nf of 2." For 197 there is no such remark. I conclude that there is no nebula corresponding to the position and description of Swift 197. The position of Swift 198 is $20^h 37^m 8^s, -30^\circ 12'7$.

Swift 199. The position is $20^h 37^m 28^s, -30^\circ 3'8$.

Swift 241. I saw nothing in the place given by Swift, but measured one 34 seconds following at nearly the same declination. It precedes a star of mag. 8, 17 seconds, $2'3$ south. This star has a companion of mag. 12 at $70^\circ, 6''$. The position of the nebula is $23^h 46^m 26^s, -28^\circ 55'2$.

Note on the Total Eclipse of the Sun, 1900 May 28, observed at Algiers. By the Rev. C. D. P. Davies, M.A.

With regard to the time of first contact chronicled on p. 589 of vol. lx., and the supposition of Mr. Crommelin that the time noted was probably five seconds late, it will be absolutely safe to read "certainly" for "probably," unless Mr. Crommelin saw the contact before he proclaimed it, as I distinctly saw it in my guiding refractor of 2-inch aperture fully five seconds before Mr. Crommelin announced it.

Note on the Moon's Eclipse Diameter. By A. C. D. Crommelin.

The results of the total solar eclipses of 1898 and 1900 have established beyond a doubt that the value of the Moon's semi-diameter now used in the *Nautical Almanac* for eclipses and occultations gives too long a duration for totality. This value ($15' 32'' 65$) was deduced by Dr. L. Struve from a discussion of the occultations observed during the total lunar eclipses of 1884 and 1888.

The American ephemeris uses the value $15' 31'' 76$ for eclipses and occultations, and increases this by $2'' 5$ for meridian observations of the bright limb.

Now the American ephemeris durations of totality were very nearly correct in the above eclipses, from which it seems clear that their value of the semi-diameter is preferable to the *Nautical Almanac* one for this purpose.

Now it occurred to me recently that the reason that a value deduced from a large number of occultations does not give correct results for total eclipses is to be sought in the great irregularity of the Moon's limb. I was particularly struck with this in watching the disappearing Sun last May. Twenty seconds before totality the lunar mountains began to break the continuity of the solar crescent, and a few seconds before totality there was no semblance of a continuous crescent, only a row of bright beads and patches. I have drawn a figure representing diagrammatically on a greatly exaggerated scale these irregularities in the Moon's outline. The outer circle is drawn to embrace the highest mountains, the inner through the deepest valleys, while the middle one is drawn midway between the two. Now it seems clear that the discussion of a large number of occultations at various points of the limb would give us the diameter of this middle circle. But since we do not call the Sun totally eclipsed if any portion of it is visible through a lunar valley, the inner circle represents the effective diameter of the Moon as regards her power of totally eclipsing the Sun. The difference between the *Nautical Almanac* and American Ephemeris values only implies an extreme depth of the deepest lunar valleys below the mean level of about 5,000 feet, which is not at all an improbable amount. The course then that I should recommend is as follows: Struve's semi-diameter of the Moon should certainly be used for occultations, and it may be used for the prediction of first and fourth contacts of total eclipses; also for partial and annular eclipses, whose accurate prediction is of minor importance. But it is so important to predict the duration and boundaries of totality with all possible accuracy that I think it would be well to use the American value, or even a slightly smaller one (say $15' 31'' 70$) for this purpose. I think this

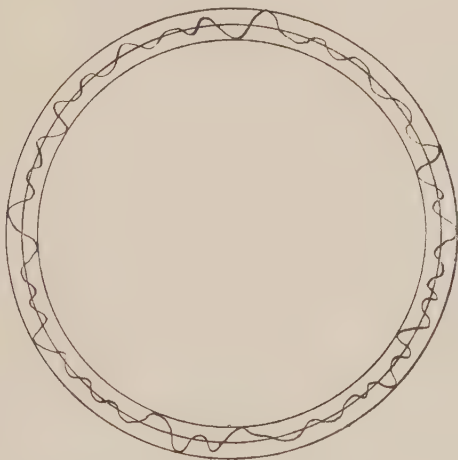
would give the duration with almost perfect accuracy ; if anything it would underestimate it, but that is on the safe side.

Curiously enough, in 1902, the American Ephemeris adopts the value $15' 32''.55$ for eclipses and occultations, and increases it by $1''.5$ for meridian observations of the bright limb.

I regard this as a distinctly retrograde step as regards total eclipses, though it is probably an improvement as regards occultations.

Perhaps I may point out a small erratum in Mr. Penrose's paper in the *Monthly Notices* for April last (lx. 7, p. 483).

He says, "Compare the arguments given for the . . . Moon's semi-diameter in the *Nautical Almanac* for the same day at noon . . . then find from these the corrections required for the assumed time in simple proportion." He has overlooked the fact that the Moon's semi-diameter under the heading eclipses is based on Struve's semi-diameter $15' 32''.65$, while the noon and midnight values are based on Hansen's bright limb semi-diameter $15' 34''.07$. It will be near enough if the noon and midnight values are diminished by $1''.4$ before proceeding to interpolate in the manner described by Mr. Penrose.



Benvenue, 55 Ulundi Road, Blackheath, S.E. :
1900 October 31.

Ephemeris for Physical Observations of the Moon for 1901.

By A. C. D. Crommelin.

Greenwich Midnight.	Selenographical		Geocentric Libration		Combined Amount.	Direc- tion.	C.
	Colong. of the Sun.	Lat.	Sel. Long. of the Earth.	Lat.			
1901. Jan. 1	48° 76	+ 1° 00	+ 2° 82	+ 0° 19	2° 83	273° 9	347° 12
2	60° 89	+ 1° 02	+ 3° 60	+ 1° 81	4° 03	296° 7	352° 77
3	73° 01	+ 1° 05	+ 4° 23	+ 3° 30	5° 37	308° 0	358° 79
4	85° 14	+ 1° 07	+ 4° 68	+ 4° 58	6° 55	314° 4	47° 1
5	97° 26	+ 1° 10	+ 4° 87	+ 5° 58	7° 40	318° 9	10° 14
6	109° 39	+ 1° 12	+ 4° 85	+ 6° 27	7° 93	322° 3	14° 83
7	121° 53	+ 1° 14	+ 4° 50	+ 6° 62	8° 01	325° 8	18° 64
8	133° 66	+ 1° 16	+ 3° 87	+ 6° 65	7° 69	329° 8	21° 50
9	145° 80	+ 1° 17	+ 2° 96	+ 6° 36	7° 02	335° 0	23° 39
10	157° 95	+ 1° 19	+ 1° 84	+ 5° 80	6° 08	342° 4	24° 29
11	170° 10	+ 1° 21	+ 0° 56	+ 5° 00	5° 03	353° 6	24° 21
12	182° 26	+ 1° 23	- 0° 80	+ 3° 98	4° 06	11° 4	23° 12
13	194° 42	+ 1° 24	- 2° 15	+ 2° 80	3° 53	37° 5	21° 03
14	206° 59	+ 1° 25	- 3° 39	+ 1° 48	3° 70	66° 4	17° 93
15	218° 76	+ 1° 27	- 4° 43	+ 0° 08	4° 43	89° 0	13° 89
16	230° 94	+ 1° 28	- 5° 20	- 1° 36	5° 38	104° 7	9° 03
17	243° 13	+ 1° 29	- 5° 63	- 2° 76	6° 27	116° 1	3° 57
18	255° 31	+ 1° 30	- 5° 68	- 4° 06	6° 99	125° 6	357° 81
19	267° 50	+ 1° 32	- 5° 34	- 5° 16	7° 42	134° 0	352° 12
20	279° 69	+ 1° 33	- 4° 65	- 5° 99	7° 58	142° 2	346° 87
21	291° 89	+ 1° 34	- 3° 68	- 6° 46	7° 44	150° 3	342° 34
22	304° 07	+ 1° 35	- 2° 51	- 6° 54	7° 00	159° 0	338° 85
23	316° 26	+ 1° 36	- 1° 26	- 6° 21	6° 34	168° 5	336° 58
24	328° 44	+ 1° 38	- 0° 03	- 5° 49	5° 49	179° 7	335° 62
25	340° 61	+ 1° 39	+ 1° 10	- 4° 42	4° 55	194° 0	336° 12
26	352° 78	+ 1° 40	+ 2° 08	- 3° 09	3° 72	213° 9	338° 07
27	4° 94	+ 1° 42	+ 2° 90	- 1° 58	3° 30	241° 4	341° 21
28	17° 09	+ 1° 43	+ 3° 55	0° 00	3° 55	270° 0	345° 85
29	29° 23	+ 1° 44	+ 4° 05	+ 1° 56	4° 34	291° 1	351° 21
30	41° 37	+ 1° 45	+ 4° 40	+ 3° 02	5° 34	304° 5	357° 03
31	53° 51	+ 1° 47	+ 4° 61	+ 4° 30	6° 30	313° 0	2° 89
Feb. 1	65° 64	+ 1° 48	+ 4° 67	+ 5° 32	7° 08	318° 7	8° 43
2	77° 78	+ 1° 49	+ 4° 55	+ 6° 05	7° 57	323° 1	13° 35
3	89° 91	+ 1° 50	+ 4° 23	+ 6° 46	7° 72	326° 8	17° 45

Greenwich Midnight.	Selenographical Colong. Lat. of the Sun.		Geocentric Libration Sel. Long. Lat. of the Earth.		Combined Amount.	Direc- tion.	C.
1901.							
Feb. 4	102°04	+1°50	+3°69	+6°54	7°51	330°6	20°64
5	114°18	+1°51	+2°93	+6°32	6°97	335°1	22°88
6	126°32	+1°51	+1°95	+5°80	6°12	341°4	24°13
7	138°47	+1°52	+0°78	+5°04	5°10	351°2	24°37
8	150°62	+1°52	-0°53	+4°07	4°10	7°4	23°61
9	162°77	+1°52	-1°92	+2°92	3°49	33°3	21°84
10	174°93	+1°52	-3°30	+1°64	3°68	63°6	19°10
11	187°10	+1°52	-4°58	+0°29	4°59	86°4	15°43
12	199°27	+1°52	-5°66	-1°10	5°77	101°0	10°92
13	211°45	+1°52	-6°44	-2°47	6°90	111°0	5°74
14	223°63	+1°52	-6°84	-3°75	7°80	118°7	0°15
15	235°82	+1°51	-6°79	-4°88	8°36	125°7	354°44
16	248°01	+1°51	-6°27	-5°77	8°52	132°6	348°95
17	260°20	+1°51	-5°31	-6°33	8°26	140°0	344°06
18	272°41	+1°51	-3°98	-6°51	7°63	148°6	340°06
19	284°61	+1°51	-2°37	-6°26	6°69	159°3	337°22
20	296°81	+1°51	-0°67	-5°59	5°63	173°2	335°76
21	309°00	+1°51	+0°98	-4°54	4°65	192°2	335°80
22	321°20	+1°51	+2°45	-3°20	4°03	217°4	337°39
23	333°38	+1°51	+3°67	-1°67	4°03	245°5	340°44
24	345°56	+1°51	+4°59	-0°06	4°59	269°2	344°73
25	357°74	+1°50	+5°22	+1°52	5°44	286°2	349°97
26	9°91	+1°50	+5°58	+2°98	6°33	298°1	355°71
27	22°07	+1°50	+5°70	+4°25	7°11	306°7	1°55
28	34°22	+1°49	+5°60	+5°27	7°69	313°3	7°12
Mar. 1	46°37	+1°49	+5°32	+6°01	8°02	318°5	12°13
2	58°52	+1°48	+4°87	+6°44	8°07	322°9	16°42
3	70°67	+1°48	+4°24	+6°56	7°81	327°1	19°85
4	82°82	+1°47	+3°45	+6°36	7°24	331°5	22°35
5	94°96	+1°46	+2°49	+5°87	6°38	337°0	23°89
6	107°11	+1°45	+1°36	+5°13	5°31	345°2	24°42
7	119°26	+1°43	+0°10	+4°16	4°16	358°6	23°97
8	131°42	+1°42	-1°26	+3°03	3°28	22°6	22°49
9	143°58	+1°41	-2°67	+1°76	3°20	56°6	20°03
10	155°74	+1°40	-4°06	+0°42	4°08	84°1	16°64
11	167°91	+1°38	-5°36	-0°96	5°45	100°2	12°42
12	180°09	+1°37	-6°46	-2°32	6°87	109°8	7°54
13	192°27	+1°35	-7°29	-3°60	8°13	116°3	2°17

Greenwich Midnight.	Selenographical Colong. Lat. of the Sun.		Geocentric Libration Sel. Long. Lat. of the Earth.		Combined Amount.	Direction.	C.
1901.							
Mar. 14	204°45	+ 1°34	- 7°73	- 4°73	9°06	121°5	356°61
15	216°64	+ 1°32	- 7°73	- 5°66	9°58	126°2	351°13
16	228°85	+ 1°31	- 7°25	- 6°30	9°61	131°0	346°05
17	241°05	+ 1°29	- 6°24	- 6°59	9°07	136°6	341°67
18	253°26	+ 1°28	- 4°79	- 6°46	8°05	143°4	338°30
19	265°48	+ 1°27	- 3°01	- 5°90	6°62	153°0	336°19
20	277°70	+ 1°25	- 1°05	- 4°92	5°03	168°0	335°57
21	289°92	+ 1°24	+ 0°92	- 3°58	3°70	194°4	336°57
22	302°13	+ 1°23	+ 2°74	- 2°01	3°40	233°7	339°19
23	314°34	+ 1°21	+ 4°28	- 0°33	4°29	265°6	343°25
24	326°55	+ 1°20	+ 5°47	+ 1°35	5°63	283°9	348°40
25	338°75	+ 1°19	+ 6°29	+ 2°89	6°92	294°7	354°20
26	350°94	+ 1°17	+ 6°72	+ 4°23	7°94	302°2	0°17
27	3°12	+ 1°16	+ 6°82	+ 5°30	8°64	307°9	5°89
28	15°30	+ 1°14	+ 6°61	+ 6°08	8°98	312°6	11°07
29	27°47	+ 1°12	+ 6°16	+ 6°54	8°99	316°7	15°52
30	39°65	+ 1°10	+ 5°47	+ 6°68	8°63	320°7	19°14
31	51°81	+ 1°08	+ 4°61	+ 6°51	7°98	324°7	21°85
April 1	63°98	+ 1°06	+ 3°58	+ 6°05	7°03	329°4	23°61
2	76°15	+ 1°04	+ 2°43	+ 5°32	5°85	335°5	24°41
3	88°31	+ 1°01	+ 1°16	+ 4°37	4°52	345°1	24°20
4	100°48	+ 0°99	- 0°18	+ 3°23	3°24	3°2	23°00
5	112°65	+ 0°97	- 1°59	+ 1°95	2°52	39°2	20°78
6	124°82	+ 0°94	- 2°98	+ 0°59	3°04	78°8	17°62
7	136°99	+ 0°92	- 4°33	- 0°80	4°40	100°5	13°61
8	149°16	+ 0°89	- 5°58	- 2°17	5°99	111°3	8°92
9	161°35	+ 0°87	- 6°64	- 3°47	7°49	117°6	3°79
10	173°53	+ 0°84	- 7°45	- 4°63	8°78	121°9	358°29
11	185°72	+ 0°82	- 7°91	- 5°60	9°69	125°3	352°89
12	197°92	+ 0°79	- 7°98	- 6°30	10°17	128°3	347°79
13	210°13	+ 0°77	- 7°60	- 6°69	10°13	131°4	343°25
14	222°34	+ 0°75	- 6°74	- 6°69	9°50	134°8	339°54
15	234°56	+ 0°72	- 5°44	- 6°28	8°31	139°1	336°91
16	246°79	+ 0°70	- 3°76	- 5°44	6°61	145°4	335°62
17	259°02	+ 0°68	- 1°82	- 4°21	4°59	156°6	335°88
18	271°25	+ 0°66	+ 0°22	- 2°67	2°68	184°7	337°80
19	283°49	+ 0°64	+ 2°19	- 0°95	2°39	246°5	341°34
20	295°72	+ 0°62	+ 3°96	+ 0°83	4°05	281°8	346°23

Greenwich Midnight.	Selenographical - Colong. Lat. of the Sun.		Geocentric Libration - Sel. Long. Lat. of the Earth.		Combined Amount.	Direc- tion.	C.
1901.							
April 21	307° 95	+ 0° 60	+ 5° 40	+ 2° 51	5° 95	294° 9	352° 03
22	320° 17	+ 0° 57	+ 6° 45	+ 3° 99	7° 58	301° 7	358° 20
23	332° 39	+ 0° 55	+ 7° 09	+ 5° 19	8° 78	306° 2	4° 22
24	344° 60	+ 0° 53	+ 7° 31	+ 6° 07	9° 50	309° 7	9° 73
25	356° 80	+ 0° 50	+ 7° 15	+ 6° 61	9° 75	312° 8	14° 48
26	9° 01	+ 0° 48	+ 6° 65	+ 6° 80	9° 52	315° 6	18° 36
27	21° 20	+ 0° 45	+ 5° 88	+ 6° 68	8° 91	318° 6	21° 32
28	33° 39	+ 0° 42	+ 4° 88	+ 6° 26	7° 93	322° 1	23° 31
29	45° 58	+ 0° 40	+ 3° 71	+ 5° 57	6° 70	326° 3	24° 34
30	57° 76	+ 0° 37	+ 2° 42	+ 4° 64	5° 23	332° 5	24° 38
May 1	69° 94	+ 0° 34	+ 1° 06	+ 3° 52	3° 68	343° 2	23° 40
2	82° 12	+ 0° 31	- 0° 33	+ 2° 25	2° 27	8° 3	21° 45
3	94° 30	+ 0° 28	- 1° 71	+ 0° 88	1° 92	62° 8	18° 51
4	106° 49	+ 0° 25	- 3° 04	- 0° 54	3° 09	100° 1	14° 68
5	118° 67	+ 0° 22	- 4° 27	- 1° 94	4° 69	114° 4	10° 11
6	130° 85	+ 0° 19	- 5° 36	- 3° 27	6° 28	121° 4	5° 00
7	143° 04	+ 0° 16	- 6° 27	- 4° 46	7° 69	125° 4	359° 62
8	155° 23	+ 0° 13	- 6° 94	- 5° 47	8° 83	128° 2	354° 23
9	167° 43	+ 0° 10	- 7° 32	- 6° 23	9° 61	130° 4	349° 09
10	179° 64	+ 0° 07	- 7° 37	- 6° 69	9° 95	132° 2	344° 47
11	191° 85	+ 0° 04	- 7° 06	- 6° 80	9° 80	133° 9	340° 59
12	204° 06	+ 0° 02	- 6° 37	- 6° 52	9° 11	135° 7	337° 68
13	216° 29	- 0° 01	- 5° 30	- 5° 84	7° 88	137° 8	335° 92
14	228° 52	- 0° 03	- 3° 90	- 4° 77	6° 16	140° 7	335° 55
15	240° 75	- 0° 06	- 2° 22	- 3° 37	4° 04	146° 6	336° 73
16	253° 00	- 0° 08	- 0° 40	- 1° 71	1° 76	166° 8	339° 53
17	265° 25	- 0° 10	+ 1° 46	+ 0° 07	1° 46	272° 7	343° 86
18	277° 50	- 0° 12	+ 3° 20	+ 1° 83	3° 69	299° 8	349° 40
19	289° 74	- 0° 15	+ 4° 73	+ 3° 45	5° 85	306° 1	355° 49
20	301° 98	- 0° 17	+ 5° 91	+ 4° 80	7° 62	309° 1	1° 91
21	314° 22	- 0° 19	+ 6° 70	+ 5° 83	8° 88	311° 0	7° 82
22	326° 45	- 0° 22	+ 7° 06	+ 6° 50	9° 59	312° 6	13° 00
23	338° 68	- 0° 24	+ 7° 00	+ 6° 80	9° 76	314° 2	17° 28
24	350° 90	- 0° 27	+ 6° 56	+ 6° 76	9° 41	315° 9	20° 59
25	3° 12	- 0° 30	+ 5° 79	+ 6° 40	8° 63	317° 9	22° 89
26	15° 33	- 0° 33	+ 4° 75	+ 5° 77	7° 48	320° 5	24° 19
27	27° 54	- 0° 35	+ 3° 51	+ 4° 89	6° 02	324° 3	24° 49
28	39° 74	- 0° 38	+ 2° 17	+ 3° 81	4° 39	330° 3	23° 79

Greenwich Midnight.	Selenographical Colong. Lat. of the Sun.		Geocentric Libration Sel. Long. Lat. of the Earth.		Combined Amount.	Direc- tion.	C.
1901.							
May 29	51°94	-0°41	+0°78	+2°57	2°69	343°1	22°08
30	64°13	-0°44	-0°61	+1°22	1°37	26°6	19°39
31	76°33	-0°47	-1°92	-0°19	1°93	95°7	15°76
June 1	88°52	-0°50	-3°12	-1°60	3°51	117°1	11°34
2	100°71	-0°53	-4°17	-3°06	5°17	122°3	6°30
3	112°91	-0°55	-5°01	-4°19	6°53	129°9	0°91
4	125°10	-0°58	-5°64	-5°25	7°70	132°9	355°44
5	137°29	-0°61	-6°05	-6°06	8°57	135°0	350°20
6	149°49	-0°64	-6°20	-6°58	9°04	136°7	345°45
7	161°69	-0°66	-6°10	-6°76	9°11	137°9	341°40
8	173°90	-0°68	-5°73	-6°57	8°72	138°9	338°28
9	186°11	-0°71	-5°10	-6°00	7°88	139°6	336°24
10	198°34	-0°73	-4°22	-5°07	6°60	140°2	335°48
11	210°57	-0°75	-3°11	-3°80	4°91	140°7	336°12
12	222°81	-0°77	-1°79	-2°28	2°90	141°9	338°78
13	235°05	-0°79	-0°33	-0°59	0°68	150°8	341°96
14	247°30	-0°81	+1°19	+1°14	1°65	313°8	346°97
15	259°56	-0°83	+2°68	+2°80	3°87	316°3	352°90
16	271°82	-0°85	+4°04	+4°25	5°86	316°5	359°24
17	284°07	-0°87	+5°14	+5°41	7°46	316°5	5°46
18	296°32	-0°89	+5°93	+6°21	8°59	316°3	11°06
19	308°57	-0°91	+6°33	+6°64	9°17	316°4	15°82
20	320°81	-0°93	+6°32	+6°71	9°22	316°7	19°57
21	333°04	-0°95	+5°92	+6°44	8°75	317°4	22°26
22	345°27	-0°97	+5°17	+5°86	7°81	318°6	23°92
23	357°50	-0°99	+4°14	+5°04	6°52	320°6	24°53
24	9°72	-1°01	+2°90	+4°01	4°95	324°1	24°12
25	21°93	-1°03	+1°54	+2°81	3°20	331°3	22°70
26	34°14	-1°06	+0°14	+1°50	1°51	354°7	20°28
27	46°35	-1°08	-1°21	+0°12	1°22	84°3	16°93
28	58°55	-1°10	-2°44	-1°27	2°75	117°5	12°72
29	70°75	-1°12	-3°48	-2°63	4°36	127°1	7°81
30	82°95	-1°14	-4°29	-3°88	5°78	132°1	2°44
July 1	95°14	-1°16	-4°85	-4°97	6°95	135°7	356°90
2	107°33	-1°18	-5°14	-5°83	7°77	138°6	351°49
3	119°53	-1°20	-5°17	-6°39	8°22	141°0	346°52
4	131°72	-1°22	-4°97	-6°63	8°29	143°1	342°24
5	143°92	-1°24	-4°56	-6°49	7°93	144°9	338°87

Greenwich Midnight.	Selenographical Colong. Lat. of the Sun.		Geocentric Libration Sel. Long. Lat. of the Earth.		Combined Amount.	Direc- tion.	C.
1901. July 6	156°12	-1°25	-3°98	-5°99	7°19	146°4	336°58
7	168°33	-1°27	-3°27	-5°13	6°08	147°5	335°52
8	180°55	-1°28	-2°42	-3°95	4°63	148°5	335°82
9	192°78	-1°29	-1°49	-2°52	2°93	149°4	337°54
10	205°01	-1°30	-0°46	-0°93	1°04	153°7	340°72
11	217°25	-1°31	+0°63	+0°73	0°96	319°2	345°39
12	229°49	-1°32	+1°75	+2°34	2°92	323°2	350°74
13	241°74	-1°33	+2°85	+3°80	4°75	323°1	356°88
14	253°99	-1°34	+3°86	+5°01	6°32	322°4	3°11
15	266°25	-1°35	+4°70	+5°90	7°54	321°5	8°97
16	278°50	-1°36	+5°28	+6°43	8°32	320°6	14°09
17	290°75	-1°37	+5°55	+6°59	8°62	319°9	18°30
18	303°00	-1°38	+5°47	+6°40	8°42	319°5	21°43
19	315°24	-1°39	+5°02	+5°90	7°75	319°6	23°48
20	327°48	-1°40	+4°25	+5°12	6°65	320°3	24°45
21	339°71	-1°42	+3°20	+4°13	5°23	322°2	24°38
22	351°94	-1°43	+1°95	+2°97	3°55	326°7	23°27
23	4°16	-1°44	+0°58	+1°69	1°79	341°1	21°16
24	16°38	-1°45	-0°82	+0°35	0°89	66°9	18°10
25	28°59	-1°46	-2°13	-1°02	2°36	115°6	14°17
26	40°80	-1°47	-3°29	-2°36	4°05	125°6	9°48
27	53°00	-1°48	-4°21	-3°62	5°55	130°7	4°26
28	65°20	-1°49	-4°84	-4°72	6°76	134°3	358°72
29	77°39	-1°50	-5°12	-5°61	7°60	137°6	353°20
30	89°58	-1°50	-5°08	-6°23	8°04	140°8	347°98
31	101°76	-1°51	-4°71	-6°52	8°04	144°2	343°39
Aug. 1	113°95	-1°51	-4°09	-6°44	7°63	147°6	339°65
2	126°13	-1°52	-3°28	-5°97	6°81	151°2	337°00
3	138°32	-1°52	-2°35	-5°14	5°65	155°4	335°62
4	150°52	-1°52	-1°37	-3°99	4°22	161°1	335°60
5	162°72	-1°52	-0°40	-2°59	2°62	171°2	337°04
6	174°93	-1°52	+0°55	-1°04	1°18	207°9	339°89
7	187°15	-1°52	+1°44	+0°58	1°55	291°9	344°04
8	199°38	-1°52	+2°29	+2°16	3°15	313°3	349°25
9	211°61	-1°52	+3°08	+3°60	4°74	319°4	355°13
10	223°84	-1°51	+3°79	+4°81	6°12	321°8	1°25
11	236°08	-1°51	+4°40	+5°73	7°22	322°5	7°15
12	248°33	-1°51	+4°85	+6°31	7°95	322°5	12°48

Greenwich Midnight.	Selenographical Colong. Lat. of the Sun.		Geocentric Libration Sel. Long. Lat. of the Earth.		Combined Amount.	Direc- tion.	C.
1901.							
Aug. 13	260°58	-1°51	+5°09	+6°53	8°27	322°1	16°97
14	272°82	-1°51	+5°08	+6°41	8°18	321°6	20°47
15	285°07	-1°51	+4°79	+5°95	7°63	321°2	22°91
16	297°31	-1°50	+4°20	+5°22	6°70	321°2	24°27
17	309°55	-1°50	+3°32	+4°25	5°39	322°0	24°54
18	321°78	-1°50	+2°21	+3°10	3°81	324°5	23°75
19	334°01	-1°50	+0°91	+1°84	2°05	333°7	21°96
20	346°23	-1°50	-0°48	+0°50	0°69	43°8	19°20
21	358°45	-1°50	-1°89	-0°86	2°08	114°5	15°56
22	10°66	-1°50	-3°21	-2°19	3°89	124°3	11°13
23	22°87	-1°49	-4°35	-3°44	5°54	128°3	6°13
24	35°07	-1°49	-5°21	-4°56	6°92	131°2	0°73
25	47°26	-1°48	-5°74	-5°49	7°94	133°7	355°21
26	59°45	-1°48	-5°87	-6°15	8°51	136°3	349°87
27	71°63	-1°47	-5°58	-6°51	8°57	139°4	344°99
28	83°81	-1°46	-4°91	-6°50	8°15	142°9	340°87
29	95°98	-1°45	-3°91	-6°10	7°25	147°3	337°76
30	108°16	-1°44	-2°69	-5°31	5°95	153°1	335°87
31	120°33	-1°43	-1°35	-4°17	4°38	162°1	335°44
Sept. 1	132°51	-1°42	+0°01	-2°75	2°75	180°2	336°50
2	144°69	-1°40	+1°29	-1°16	1°74	228°0	339°07
3	156°88	-1°39	+2°43	+0°49	2°48	281°4	343°00
4	169°08	-1°38	+3°40	+2°10	4°00	301°7	348°04
5	181°28	-1°36	+4°19	+3°55	5°49	310°3	353°80
6	193°49	-1°35	+4°82	+4°78	6°79	314°8	359°85
7	205°71	-1°33	+5°25	+5°72	7°76	317°5	5°76
8	217°93	-1°32	+5°51	+6°34	8°40	319°0	11°17
9	230°16	-1°30	+5°58	+6°60	8°64	319°8	15°83
10	242°39	-1°29	+5°45	+6°51	8°49	320°1	19°58
11	254°62	-1°28	+5°09	+6°10	7°94	320°2	22°31
12	266°86	-1°27	+4°51	+5°39	7°03	320°1	23°99
13	279°09	-1°25	+3°68	+4°44	5°76	320°4	24°59
14	291°32	-1°24	+2°65	+3°31	4°24	321°3	24°13
15	303°55	-1°22	+1°43	+2°03	2°48	324°8	22°64
16	315°77	-1°21	+0°07	+0°68	0°68	354°1	20°15
17	327°99	-1°20	-1°36	-0°69	1°52	116°9	16°76
18	340°20	-1°18	-2°79	-2°04	3°46	126°2	12°60
19	352°41	-1°17	-4°12	-3°31	5°29	128°8	7°81

Greenwich Midnight.	Selenographical Colong. Lat. of the Sun.		Geocentric Libration Sel. Long. Lat. of the Earth.		Combined Amount.	Direc- tion.	C.
1901. Sept. 20	4°62	-1°15	-5°28	-4°45	6°90	130°1	2°61
21	16°81	-1°14	-6°16	-5°41	8°20	131°3	357°20
22	29°00	-1°12	-6°69	-6°14	9°07	132°5	351°86
23	41°18	-1°10	-6°80	-6°58	9°47	134°1	346°85
24	53°36	-1°08	-6°47	-6°67	9°29	135°9	342°43
25	65°53	-1°06	-5°68	-6°38	8°55	138°3	338°89
26	77°69	-1°04	-4°49	-5°69	7°25	141°7	336°47
27	89°85	-1°01	-2°99	-4°61	5°50	147°0	335°42
28	102°01	-0°99	-1°30	-3°21	3°46	158°0	335°90
29	114°16	-0°96	+0°43	-1°58	1°64	195°2	337°99
30	126°33	-0°94	+2°10	+0°16	2°12	274°3	341°61
Oct. 1	138°49	-0°91	+3°58	+1°86	4°04	297°5	346°52
2	150°67	-0°89	+4°82	+3°42	5°91	305°4	352°29
3	162°85	-0°86	+5°76	+4°74	7°46	309°5	358°44
4	175°03	-0°84	+6°40	+5°75	8°60	311°9	4°47
5	187°23	-0°82	+6°73	+6°41	9°29	313°6	10°03
6	199°43	-0°79	+6°80	+6°72	9°57	314°7	14°86
7	211°63	-0°77	+6°58	+6°68	9°38	315°4	18°80
8	223°84	-0°75	+6°13	+6°30	8°79	315°8	21°75
9	235°06	-0°72	+5°45	+5°64	7°84	316°0	23°68
10	248°27	-0°70	+4°57	+4°71	6°56	315°9	24°57
11	260°49	-0°68	+3°51	+3°59	5°02	315°6	24°39
12	272°70	-0°66	+2°30	+2°32	3°26	315°3	23°18
13	284°92	-0°64	+0°96	+0°95	1°35	314°7	20°96
14	297°13	-0°61	-0°45	-0°44	0°63	134°4	17°80
15	309°34	-0°59	-1°89	-1°82	2°62	133°9	13°84
16	321°55	-0°57	-3°30	-3°12	4°54	133°4	9°29
17	333°75	-0°55	-4°62	-4°30	6°31	133°0	4°15
18	345°94	-0°52	-5°77	-5°31	7°84	132°6	358°85
19	358°13	-0°50	-6°68	-6°09	9°05	132°4	353°58
20	10°32	-0°47	-7°26	-6°61	9°81	132°3	348°54
21	22°49	-0°45	-7°47	-6°80	10°10	132°3	344°00
22	34°67	-0°42	-7°24	-6°75	9°90	133°0	340°19
23	46°83	-0°39	-6°55	-6°11	8°96	133°0	337°33
24	58°98	-0°36	-5°43	-5°18	7°50	133°6	335°68
25	71°13	-0°33	-3°91	-3°88	5°51	134°8	335°45
26	83°28	-0°30	-2°10	-2°30	3°11	137°6	336°83
27	95°41	-0°27	-0°15	-0°54	0°56	164°5	339°85

Greenwich Midnight.	Selenographical		Geocentric Libration		Combined Amount.	Direc- tion.	C.
	Colong. of the Sun.	Lat.	Sel. Long. of the Earth.	Lat.			
1901. Oct. 28	107°55	-0°24	+1°82	+1°27	2°22	304°9	344°39
29	119°70	-0°20	+3°65	+2°97	4°70	309°1	350°07
30	131°85	-0°17	+5°23	+4°44	6°86	310°3	356°35
31	144°00	-0°14	+6°46	+5°59	8°55	310°7	2°69
Nov. 1	156°16	-0°11	+7°29	+6°37	9°67	311°1	8°60
2	168°33	-0°08	+7°71	+6°77	10°27	311°3	13°76
3	180°50	-0°05	+7°74	+6°79	10°30	311°3	17°98
4	192°69	-0°03	+7°41	+6°48	9°85	311°2	21°19
5	204°88	0°00	+6°76	+5°85	8°94	310°9	23°33
6	217°07	+0°02	+5°86	+4°97	7°68	310°3	24°49
7	229°26	+0°05	+4°76	+3°88	6°14	309°2	24°56
8	241°46	+0°08	+3°51	+2°64	4°40	307°0	23°59
9	253°66	+0°10	+2°15	+1°28	2°50	300°8	21°63
10	265°86	+0°13	+0°74	-0°12	0°75	260°8	18°70
11	278°06	+0°15	-0°69	-1°52	1°67	155°6	14°93
12	290°26	+0°17	-2°09	-2°85	3°54	143°7	10°44
13	302°46	+0°20	-3°42	-4°06	5°31	139°9	5°45
14	314°65	+0°23	-4°63	-5°11	6°90	137°8	0°20
15	326°84	+0°25	-5°70	-5°94	8°23	136°2	354°92
16	339°03	+0°28	-6°55	-6°52	9°25	134°9	349°87
17	351°20	+0°30	-7°14	-6°79	9°86	133°6	345°24
18	3°38	+0°33	-7°42	-6°74	10°03	132°3	341°30
19	15°54	+0°36	-7°34	-6°33	9°70	130°8	338°20
20	27°70	+0°39	-6°87	-5°56	8°84	129°0	336°14
21	39°85	+0°42	-5°99	-4°44	7°45	126°5	335°33
22	51°99	+0°45	-4°71	-3°01	5°59	122°6	335°98
23	64°13	+0°48	-3°08	-1°34	3°36	113°5	338°21
24	76°26	+0°51	-1°20	+0°45	1°28	69°4	342°04
25	88°39	+0°54	+0°81	+2°22	2°36	340°0	347°28
26	100°52	+0°57	+2°80	+3°82	4°73	323°8	353°49
27	112°65	+0°60	+4°61	+5°14	6°91	318°1	0°06
28	124°78	+0°63	+6°10	+6°09	8°62	315°0	6°41
29	136°93	+0°66	+7°17	+6°63	9°77	312°8	12°07
30	149°07	+0°68	+7°78	+6°77	10°31	311°0	16°78
Dec. 1	161°23	+0°71	+7°91	+6°53	10°25	309°5	20°27
2	173°38	+0°73	+7°61	+5°97	9°67	308°1	22°91
3	185°55	+0°76	+6°92	+5°14	8°62	306°6	24°32
4	197°72	+0°78	+5°93	+4°09	7°20	304°6	24°66

Greenwich Midnight.	Selenographical Colong. Lat. of the Sun.		Geocentric Libration Sel. Long. Lat. of the Earth.		Combined Amount.	Direc- tion.	C.
1901.							
Dec. 5	209°90	+ 0°80	+ 4°71	+ 2°88	5°52	301°4	23°96
6	222°08	+ 0°82	+ 3°35	+ 1°56	3°70	295°0	22°23
7	234°26	+ 0°84	+ 1°92	+ 0°18	1°93	275°4	19°55
8	246°45	+ 0°86	+ 0°49	- 1°20	1°30	202°2	15°97
9	258°64	+ 0°88	- 0°90	- 2°54	2°69	160°5	11°63
10	270°83	+ 0°90	- 2°20	- 3°77	4°37	149°7	6°73
11	283°02	+ 0°92	- 3°37	- 4°84	5°89	145°2	1°47
12	295°21	+ 0°94	- 4°39	- 5°71	7°21	142°4	356°13
13	307°39	+ 0°96	- 5°24	- 6°33	8°21	140°4	350°98
14	319°57	+ 0°98	- 5°90	- 6°65	8°89	138°4	346°24
15	331°75	+ 1°00	- 6°36	- 6°66	9°21	136°3	342°13
16	343°93	+ 1°02	- 6°58	- 6°33	9°13	133°9	338°87
17	356°09	+ 1°05	- 6°54	- 5°66	8°65	130°9	336°57
18	8°26	+ 1°07	- 6°22	- 4°67	7°78	126°9	335°41
19	20°41	+ 1°09	- 5°59	- 3°38	6°53	121°2	335°56
20	32°55	+ 1°11	- 4°63	- 1°86	4°99	111°9	337°15
21	44°69	+ 1°14	- 3°36	- 0°19	3°36	93°2	340°25
22	56°82	+ 1°16	- 1°81	+ 1°52	2°36	50°0	344°79
23	68°95	+ 1°18	- 0°06	+ 3°15	3°15	1°1	350°51
24	81°07	+ 1°20	+ 1°76	+ 4°56	4°89	338°9	356°98
25	93°19	+ 1°22	+ 3°53	+ 5°65	6°66	328°0	3°54
26	105°31	+ 1°24	+ 5°06	+ 6°35	8°12	321°5	9°67
27	117°44	+ 1°26	+ 6°24	+ 6°62	9°10	316°7	14°96
28	129°57	+ 1°28	+ 6°98	+ 6°49	9°53	312°9	19°17
29	141°71	+ 1°29	+ 7°23	+ 6°01	9°39	309°7	22°18
30	153°86	+ 1°30	+ 7°02	+ 5°23	8°75	306°7	23°99
31	166°01	+ 1°32	+ 6°39	+ 4°21	7°65	303°4	24°69
1902.							
Jan. 1	178°16	+ 1°33	+ 5°41	+ 3°03	6°20	299°2	24°28

The longitudes are reckoned in the plane of the Moon's equator, the axis of reference being the radius which passes through the mean centre of the visible disc. This axis therefore rotates with the Moon, and is not fixed in space.

The inclination of the Moon's equator to the ecliptic is taken as 1°523, the value used in the *Connaissance des Temps*, that given by the *Nautical Almanac* being 1°536.

The physical librations in longitude and latitude, as given by Professor Franz's formulæ, have been applied; their values are taken from the *Berliner Jahrbuch* for the days given there, and interpolated by a graphical method for the other days. But the

signs in the *Jahrbuch* require to be reversed in order to reduce to the system used here.

The colongitude of the Sun is 90° (or 450°) *minus* his selenographical longitude. It also is the selenographical longitude of the morning terminator reckoned eastward from the mean centre of the disc. Hence its value is approximately 270° , 0° , 90° , 180° at new Moon, first quarter, full Moon, last quarter respectively. The longitude of the evening terminator is of course 180° greater or less than that of the morning one.

When the geocentric libration in longitude is positive, the region brought into view is on the west limb; when negative, on the east.

When the geocentric libration in latitude is positive, the region brought into view is at the Moon's north pole; when negative, at the south.

The column "Combined Amount" gives the distance between the apparent and mean centres of the disc, and the column "Direction" gives the position-angle of the apparent centre from the mean centre, or, which is the same thing, the position-angle of the region which is most carried into view by libration. The angles are reckoned eastward from the northern extremity of the Moon's axis.

C denotes the geocentric position-angle of the northern extremity of the Moon's axis measured eastward from the northernmost point of the disc. This quantity is given now for the first time, at the suggestion of Professor W. H. Pickering. It has been computed by the second formula given in the Preface to the *Nautical Almanac*, but the coordinates of the Moon's equator have been taken from the *Connaissance des Temps*, so as to make this column consistent with the rest of the ephemeris.

The terms "East" and "West" are used throughout with reference to our sky, and not as they would appear to an observer on the Moon.

At the suggestion of Mr. S. A. Saunder I give the method for finding the altitude of the Sun at a given point on the Moon whose position is defined: (1) by selenographical longitude and latitude; (2) by direction cosines.

In either case the Sun's selenographical colongitude and latitude (K, L supposed) must be found by interpolation from the ephemeris for the given time.

In the first case let the given point be in the position longitude M, latitude N. Longitudes are reckoned from the meridian passing through the mean centre of the disc, and the positive direction is that towards Mare Crisium. North latitudes are considered positive.

Then

$$\text{sine Sun's altitude} = \sin L \sin N + \cos L \cos N \sin (K + M).$$

In the second case let ξ , η , ζ be the direction cosines of the given point. The axes are (1) that diameter of the Moon's

equator which is 90° from the mean centre of the disc; (2) the Moon's polar axis; (3) the diameter through the mean centre of the disc. The positive directions are as above. Mr. Saunder, I understand, proposes to issue some maps of portions of the Moon's surface from which the coordinates ξ , η , ζ can be taken at sight.

Then the Sun's direction cosines are:

$$\cos K \cos L, \sin L, \sin K \cos L,$$

and sine Sun's altitude

$$= \xi \cos K \cos L + \eta \sin L + \zeta \sin K \cos L.$$

Neither formula is convenient when the Sun's altitude is very great, for an angle near 90° cannot be accurately determined from its sine. However, when the Sun is high the shadows are so inconspicuous that it is not necessary to compute his altitude with great accuracy.

Examples:

(1) To find the Sun's altitude at Mösting A, 1901 April 27^d 9^h, G.M.T.

By interpolation from the ephemeris $K=19^\circ.68$, $L=+0^\circ.45$.

Place of Mösting A, $M=-5^\circ 10'.3$, $N=-3^\circ 11'.4$.

(From *Monthly Notices*, lx. 3, p. 181).

$\therefore$ sine Sun's altitude

$$\begin{aligned} &= -\sin 0^\circ.45 \sin 3^\circ 11'.4 + \cos 0^\circ.45 \cos 3^\circ 11'.4 \sin (19^\circ.68 - 5^\circ.17) \\ &= -.0007 + .2502 = +.2495. \end{aligned}$$

$\therefore$ Sun's altitude $= 14^\circ.45$.

(2) To find the Sun's altitude at Euclides 1901 October 25^d 13^h, G.M.T. By interpolation from the ephemeris $K=71^\circ.64$, $L=-0^\circ.33$.

Place of Euclides $\xi=-.4887$, $\eta=-.1281$.

(From *Monthly Notices*, lx. 3, p. 182.)

$$\begin{aligned} \text{And } \zeta &= \sqrt{1 - \xi^2 - \eta^2} = \sqrt{1 - .2388 - .0164} = \sqrt{.7448} \\ &= +.8630. \end{aligned}$$

Then sine Sun's altitude $= -.4887 \cos 71^\circ.64 \cos 0^\circ.33$

$$+ .1281 \sin 0^\circ.33$$

$$+ .8630 \sin 71^\circ.64 \cos 0^\circ.33$$

$$= -.1539 \quad + .0001 \quad + .8190 \quad = +.6652$$

Hence, Sun's altitude $= 41^\circ.70$.

Benvenue, 55 Ulundi Road, Blackheath, S.E.
1900 October 27.

